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# THE SCIENTIFIC MONTHLY

*EDITED BY J. McKEEN CATTELL*

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THE SCIENTIFIC MONTHLY

DECEMBER, 1921

# THE INBRED DESCENDANTS OF CHARLEMAGNE: A GLANCE AT THE SCIENTIFIC SIDE OF GENEALOGY

By Dr. DAVID STARR JORDAN

STANFORD UNIVERSITY

See the march of history
Strewn with cast-off finery,
And the way of common things
Cluttered with the pomp of kings.

THERE has lately been placed in my hands a great chart of American genealogy running back to the marriages of Isabel de Vermandois with two successive husbands—Robert de Bellomont, Earl of Leicester, and William, Second Earl of Warren and Surrey—and showing the lines of descent of some hundreds of well-known families from the beginning of the twelfth century, the reign of Henry I of England, down to the present time. This chart, the work of Miss Sarah Louise Kimball of Palo Alto, California, furnishes the text of the present essay. It embodies the results of long and patient research by its maker, supplemented by conclusions of many other experts in genealogy. But my present purpose is to consider only one scientific phase of the matter.

And first I may premise that to the biologist an ancestor is not primarily a forbear, but a carrier of inheritable potentialities. For men and women transmit to posterity not their actually developed traits, but rather their inborn tendencies, "the raw material out of which character is forged", a complex of potentialities. That is to say, heredity carries potentiality, not the completed results of education and environment. I shall, however, waive further discussion of the physiology or psychology of inheritance; I wish only to indicate some generalizations drawn (largely) from a study of Miss Kimball's chart.

Let us first note that notwithstanding its elaboration, its thousand or more ancestral names constitute merely a fragment, a scant shred in the great warp and woof of the genealogy of even a single person, or of the record of descendants of even a single pair.[1] For if the an-

[1] In this connection I remarked with interest that in the "Waldo Genealogy" (1902) by Waldo Lincoln of Worcester, Mass., the record of a single family for less than three hundred years, or eight generations, upwards

cestry of one individual running back to the twelfth century could be written out, using a square inch to each name, it would occupy something like a fourth of a square mile. A full chart of all the two hundred millions, more or less, of people of English ancestry scattered over the world would cover some twenty-five millions of square miles.

The simplest numerical calculation gives bewildering results. As each person has had two parents, four grandparents, eight great-grandparents, and so back endlessly in geometrical progression, every adult of today, allowing three generations to a century, would (if facts permitted) count not less than 134,192,256 separate ancestors in the year 1100. Furthermore as in the indicated progression with a ratio of two, the sum of the series is equivalent, minus one, to its highest term, each descendant should have 134,192,255 intervening forbears, making 268,384,511 in all. Again, each child of this generation has twice as many ancestors as either parent—that is 536,769,022 in all, of which incalculable number not one would have died in infancy or without issue. This computation, however, has led us to figures manifestly impossible in view of the fact that the total population of England in 1100 did not exceed two millions, and that probably not one-tenth of these, beset as they were by war and pestilence, left permanent descendants.

The simple explanation is, of course, that every ancient forbear must be counted over and over thousands of times in each individual case. Indeed, no one can guess how many tangled lines lead down to him from a single pair in the days of Henry I.

Conversely, if any one couple of the twelfth century and their successors left on an average four children, thus doubling the number three times to the century, their descendants alone, facts permitting, would count 134,192,256, as would the descendants of every other pair similarly fertile,—the whole making a nominal total far exceeding the present population of the globe! Thus, in this computation also, intervening individuals must be reckoned over and over again almost to infinity.

These conclusions as to the tangled lineage of the English people give a clue to the origin and persistence of racial traits in general; they are the stigmata of blood relationship. Moreover, as we have abundant evidence that the children of Warren and Isabel, like hundreds of other early notables, were descended from Alfred the Great and Charlemagne alike, it is not without reason that Miss Kimball calls the English people "the inbred descendants of Charlemagne".

of 19,000 persons are named as either descended from Cornelius Waldo and Hannah Cogswell—both of whom came from Berwick in Wiltshire, England, to Ipswich, Massachusetts, about 1640—or else married to one of their posterity; these many individuals were residents of 11,700 different towns in the United States. Besides Waldo, upwards of 3,000 other surnames appear, brought into the series by the marriage of Waldo women.

This fact now leads us to another important consideration; noble and peasant are really of one blood. For studies of American ancestry show clearly the effects of the law of primogeniture. The eldest sons of "good families" or of the nobility naturally developed into Royalists and Cavaliers; younger sons and daughters' sons, left without inheritance, became as easily Roundheads, Dissenters and Puritans. The legend on one of Cromwell's battle flags asked: "Why should the elder son have everything and we nothing?" To put it another way, why should "blue blood" be supposed to flow in the veins of the first born only?

Fortunately, those exposed to the deteriorating influences of ease and unearned power were few in number, a conspicuous minority. The others became part of the mass of commoners who have made England great. Samuel Johnson once cynically observed that primogeniture is an excellent thing, as "it ensures that there shall be but one fool in the family!" Happily it also provides that the high qualities which in other days set nobleman apart from peasant shall be spread through the whole body of the people by means of a constant transfusion from the "first estate" to the third. The lack of such a system left France, especially, a prey to the reaction inevitable in a people overrun by a hungry and impecunious nobility.

Miss Kimball's chart shows plainly the method by which the diffusion takes place. The daughter of a king, for example, marries a nobleman; one of her descendants takes a squire or younger son; a daughter of the squire marries a yeoman, whose children are accordingly of kingly descent. And every farmer of English lineage may boast of as much of the "germ plasm" of William, Alfred, or Charlemagne as any royal household in Europe; reversedly, plebeian blood may be mingled with the "bluest", usually to the betterment of both. As a matter of fact, indeed, very few Englishmen or Americans of English origin are without royal blood; nor is it likely that the coat of arms of any king living does not conceal the bar sinister of the peasant.

At the beginning of the twelfth century, as already stated, Isabel de Vermandois married successively Robert de Bellomont, Earl of Leicester, and William de Warren, Earl of Warren and Surrey. The charms or virtues of that far-off lady are not concerned in this discussion, any more than the manly qualities of either of the earls, though all three exalted personages were no doubt ancestors of yours, gentle reader, as well as of the present writer.

Isabel died on February 13, 1131. Her record comes down to us because of a very distinguished lineage, her ancestral line on both sides leading back through six separate strains to Charlemagne. She was the daughter of Prince Hugh the Great, Duke of France and Burgundy, leader in the First Crusade and father of Hugh Capet, King of

France; her mother, Adelheid de Vermandois, boasted blood equally blue, and her second husband was descended from Alfred.

By the Earl of Leicester, Isabel had two children—Robert and Elizabeth de Bellomont; by the Earl of Warren, two others—Gondred and Ada de Warren. Each of the four lines of descent then passes through a long series of English nobility, each allowing a younger son or daughter, or daughter's son to drop from time to time into the undistinguished ranks of the middle class or even into the common peasantry, while a few of the line of Elizabeth de Bellomont, though by no means the most eminent of their group, were set apart by laws of inheritance as occupants of royal thrones. Meanwhile, as I have implied, the elder sons, holding land and titles, remained in the Cavalier-Tory-Conservative caste, while their disinherited brothers and sisters became Dissenters, of whom many of the most obstinate or most enterprising sought freedom or fortune in the New World.

To illustrate these propositions I give below a series of ancestral records, each showing one of the many "direct lines" leading down from Isabel de Vermandois to Americans, well-known or otherwise.

## GEORGE WASHINGTON

Let us begin with George Washington, a man of the highest personal character and unquestioned statesmanship, but socially rather a typical English country squire, though one of the wealthiest colonials of his day. The reasons which lay behind the emigration of Washington's ancestors to Virginia I shall not try to indicate, but apparently they did not seek fortune nor freedom of worship.

Robert de Bellomont, Earl of Leicester, m. Isabel de Vermandois
Elizabeth de Bellomont m. Gilbert de Clare, Earl of Pembroke
Richard de Clare, "Strongbow," Earl of Pembroke, m——
Isabel de Clare m. William le Maréchal, Earl of Pembroke
Eve de Maréchal m. William, Baron de Braose
Maude de Braose m. Roger, Baron Mortimer
Edmund, Baron Mortimer
Roger, Baron Mortimer
Edmund Mortimer
Roger Mortimer, Earl of March
Edmund Mortimer, Earl of March
Elizabeth Mortimer m. Sir Henry Percy, "Hotspur," Earl of Northumberland
Henry Percy, Earl of Northumberland
Margaret Percy m. Sir William Gascoigne
Elizabeth Gascoigne m. Gilbert de Talboys
Sir George de Talboys
Anne de Talboys m. Sir Edward Dymoke
Frances Dimoke m. Thomas Windebank
Mildred Windebank m. Robert Reade
Col. George Reade (Virginia, 1637)
Mildred Reade m. Col. Augustine Warner
Mildred Warner m. Lawrence Washington
Augustine Washington m. Mary Ball
George Washington

## ABRAHAM LINCOLN

My next example presents certain marked contrasts. Beginning with the same aristocratic ancestry, the line of descent passes into Wales, then through a group of Welsh farmers, one of whom, doubtless to better his condition, came over to Pennsylvania, whence his pioneer descendants moved on to Virginia and westward. Out of this series rose one who became the most truly eminent statesman of his century. The career of Lincoln thus perfectly illustrates the possibilities of "noble" self-extrication among a people unburdened by the caste system of Europe.

Robert de Bellomont, Earl of Leicester, m. Isabel de Vermandois
Elizabeth de Bellomont m. Gilbert de Clare, Earl of Pembroke
Richard de Clare, "Strongbow," Earl of Pembroke
Isabel de Clare m. William le Maréchal, Earl of Pembroke
Eve de Maréchal m. William, Baron de Braose
Maude de Braose m. Roger, Baron Mortimer
Edmund, Baron Mortimer
Roger, Baron Mortimer
Maude Mortimer m. John, Lord Charleton
Jane de Charleton m. John, Baron Le Strange
Elizabeth Le Strange m. Gryffydd Wychan
Gryffydd Wychan
Lowry Wychan m. Robert Puleston
John Puleston
Margaret Puleston m. David ap Ievan ap Einion
Einion ap David
Griffith ap Llewellyn
Catherine Griffith m. Edward ap Evan
Lewis ap Griffith m. Ellen Edwards
Robert ap Lewis
Evan ap Robert
Evan ap Evan
Cadwallader Evans (Pennsylvania, 1700)
Sarah Evans m. John Hank
John Hank
Joseph Hank (Virginia about 1740) m. Nancy Shipley
Nancy Hanks m. Thomas Lincoln
ABRAHAM LINCOLN

## GEORGE V

We have seen that the early English forbears of Washington and Lincoln are identical for two hundred years and more. It is interesting also to note that the ancestry of the present king of England (as well as that of the late Kaiser and most of the continental princes now in exile or otherwise) derives from the same initial series.

Robert de Bellomont, Earl of Leicester, m. Isabel de Vermandois
Elizabeth de Bellomont m. Gilbert de Clare, Earl of Pembroke
Richard de Clare, "Strongbow," Earl of Pembroke
Isabel de Clare m. William le Maréchal, Earl of Pembroke

Eve de Maréchal m. William, Baron de Braose
Maude de Braose m. Roger, Baron Mortimer
Edmund, Baron Mortimer
Roger, Baron Mortimer
Edmund Mortimer
Roger Mortimer, Earl of March
Anne Mortimer m. Richard Plantagenet, Earl of Cambridge
Richard Plantagenet, Earl of York, m. Cecily Neville
Edward IV m. Elizabeth Woodbridge
Elizabeth Plantagenet m. Henry VII (Tudor)
Margaret Tudor m. James IV (Stuart) of Scotland
James V (Stuart)
Mary Stuart, Queen of Scots, m. Lord Darnley
James I (Stuart, James VI of Scotland)
Elizabeth Stuart m. Frederick V. of Bohemia
Sophia m. Ernest Augustus of Brunswick
George I. m. Sophia Dorothea
George II m. Wilhelmina Carolina of Brandenburg-Anspach
Frederick Louis, Prince of Wales
George III m. Charlotte Sophia of Mecklenburg-Strelitz
Edward, Duke of Kent, m. Victoria Mary Louise of Saxe-Coburg-Gotha
Victoria m. Albert of Saxe-Coburg-Gotha
Edward VII (Guelph) m. Alexandra of Denmark
George V

## GROVER CLEVELAND

This "first citizen" of our land also belongs to the Bellomont-Vermandois line.

Robert de Bellomont, Earl of Leicester, m. Isabel de Vermandois
Elizabeth de Bellomont m. Gilbert de Clare, Earl of Pembroke
Robert de Bellomont, "the Consul," Earl of Gloucester
Mabel de Bellomont m. William de Redvers de Vernon, Earl of Devon
Mary de Redvers de Vernon m. Peter Prouz
William Prouz
Walter Prouz
William Prouz
Sir William Prouz
William Prouz
Alice Prouz m. Sir Roger Moelis
Alice Moelis m. John Wotton
Alice Wotton m. Sir John Chichester
Richard Chichester
Nicholas Chichester
John Chichester
Amias Chichester
Frances Chichester m. John Wyatt
Margaret Wyatt m. Matthew Allyn of Cambridge, Mass.
Mary Alleyn m. Capt. Benjamin Newberry
Rebecca Newberry m. Samuel Marshall
Abiel Marshall
Sarah Marshall m. James Hyde
Abiah Hyde m. Rev. Aaron Cleveland
William Cleveland m. Margaret Falley
Richard Falley Cleveland
Grover Cleveland

## THEODORE ROOSEVELT

Two lines of descent from Isabel down to Roosevelt are on record, the one leading through a long series of Scottish worthies, the other by way of the Puritan forbears of Jonathan Edwards.

Robert de Bellomont, Earl of Leicester, m. Isabel de Vermandois
Elizabeth de Bellomont m. Gilbert de Clare, Earl of Pembroke
Richard de Clare, "Strongbow," Earl of Pembroke
Isabel de Clare m. William le Maréchal, Earl of Pembroke
Isabel Marshall m. Robert Bruce, Earl of Annandale
Robert Bruce, Earl of Warwick
Robert Bruce, King of Scotland
Marjory Bruce m. Walter, High "Steward" of the King
Robert II (Stuart), King of Scotland
Robert III, King of Scotland
Marjory Stewart m. Sir Duncan Campbell
Elizabeth Stuart m. Sir James Douglas
Sir James Douglas
Sir John Douglas
James Douglas
Arthur Douglas
John Douglas
James Douglas
John Douglas
Euphemia Douglas m. Dr. John Irvine (Georgia, 1765)
Anne Irvine m. Capt. James Bulloch
Major James Stephens Bulloch
Martha Bulloch m. Theodore Roosevelt (1)
THEODORE ROOSEVELT

## ROBERT EDWARD LEE

I may next present one of the greatest of American generals, whose forbears throughout, so far as the present recorded line goes, were people of at least local distinction.

William de Warren, Earl of Warren and Surrey, m. Isabel de Vermandois
Mildred de Warren m. Roger de Bellomont de Newburgh, Earl of Warwick
Waleran de Newburgh, Earl of Warwick
Alice de Newburgh m. William, Baron de Mauduit
Isabel de Mauduit m. William, Baron de Beauchamp
William de Beauchamp
Isabel de Beauchamp m. Sir Patrick de Chaworth
Maud Chaworth m. Henry Plantagenet, Earl of Leicester
Mary Plantagenet m. Henry Percy
Maud Percy m. Sir John Neville
Anne Neville m. Sir Thomas Blount, Lord Montjoy
Elizabeth Blount m. Arthur, Baron Wyndsore
Edith Wyndsore m. George Ludlow
Thomas Ludlow
Roger Ludlow, Governor of Massachusetts
Gabriel Ludlow
Sarah Ludlow m. Sir John Carter
John Carter m. Elizabeth Hall
Charles Carter m. Anne Butler Moore
Anne Carter m. General Henry Lee
ROBERT E. LEE

## HENRY ADAMS

A typical New England lineage of its kind is that of the descendants and forbears of Abigail Smith, the broad-minded and efficient wife of our second president. Unlike the Hanks-Lincoln series, none of the Adams line ever knew poverty, or was deprived of the education which enables a man of parts to reach his highest possible development.

Robert de Bellomont, Earl of Leicester, m. Isabel de Vermandois
Robert de Bellomont, Earl of Leicester
Margaret de Bellomont m. Saier de Quincy, Earl of Winchester
Roger de Quincy, Earl of Winchester
Margaret de Quincy m. William de Ferrers, Earl of Derby
Anne de Ferrers m. John Grey, Baron de Ruthyn
Maude de Grey m. Sir John de Norville
John de Norton
John de Norton
Richard Norton
William Norton
Rev. William Norton (Ipswich, 1630)
Rev. John Norton
Elizabeth Norton m. Col. John Quincy
Elizabeth Quincy m. Rev. William Smith
Abigail Smith m. John Adams, President of the United States
John Quincy Adams m. Louisa Catherine Johnson
Charles Francis Adams m. Abigail Brown Brooks
HENRY ADAMS

## JONATHAN EDWARDS

The ablest of the uncompromising theologians of Puritan blood was undoubtedly Jonathan Edwards.[2] His lineage is fairly typical, differing but little in its general lines from that of the others whose pioneer forbears built up Massachusetts and, through New England, the United States as it is.

Robert de Bellomont, Earl of Leicester, m. Isabel de Vermandois
Elizabeth de Bellomont m. Gilbert de Clare, Earl of Pembroke
Richard de Clare, "Strongbow," Earl of Pembroke
Isabel de Clare m. William le Maréchal, Earl of Pembroke
Eve de Maréchal m. William, Baron de Braose
Maude de Braose m. Roger, Baron Mortimer
Edmund, Baron Mortimer
Roger, Baron Mortimer
Edmund Mortimer
Roger, Baron Mortimer, Earl of March
Catherine Mortimer m. Thomas de Beauchamp, Earl of Warwick
Thomas de Beauchamp, Earl of Warwick
Richard de Beauchamp, Earl of Warwick and Albemarle
Margaret de Beauchamp m. Sir William Cavendish
Sir Thomas Cavendish

[2] "She had the hard, cold Edwards blood
Within her veins, and so she died." (Bret Harte)

Sir William Cavendish
Frances Cavendish m. Sir Henry Pierrepont
William Pierrepont
Rev. James Pierrepont, of Ipswich, Mass.
Sarah Pierrepont m. Rev. Jonathan Edwards, President of the College of New Jersey
JONATHAN EDWARDS, President of Union College

From the brothers and sisters of Jonathan Edwards have descended a remarkable group of university professors and executives:

Daniel Coit Gilman, President of Johns Hopkins
Merrill Edwards Gates, President of Rutgers
Timothy Dwight, as well as his grandson of the same name, and Theodore Dwight Woolsey, Presidents of Yale
Sereno Edwards Dwight, President of Hamilton
Egbert Coffin Smith and Edward Amasa Park, Presidents of Andover
Nicholas Murray Butler, President of Columbia
Aaron Burr, President of the College of New Jersey
Aaron Burr, Jr., Vice President of the United States
Theodore William Dwight, founder of the Columbia Law School
Charles Sedgwick Minot, of the Harvard Medical School
Theodore Roosevelt,[3] President of the United States

## SARAH LOUISE KIMBALL

As illustrative of the genealogy of the rank and file of cultivated Americans, I present below that of the recorder of Isabel's progeny.

William de Warren, Earl of Warren and Surrey, m. Isabel de Vermandois
Gondred de Warren m. Roger de Bellomont de Newburgh
Waleran, Earl of Warwick
Alice de Newburgh m. William, Baron Mauduit
Isabel de Mauduit m. William, Baron Beauchamp
William de Beauchamp, Earl of Warwick
Isabel de Beauchamp m. Sir Patrick de Chaworth
Maud de Chaworth m. Henry Plantagenet, Earl of Lancaster and Leicester
Mary Plantagenet m. Henry Percy
Henry Percy m. Margaret Neville
Maud Percy m. Sir John Neville
Sir Ralph Neville, Earl of Westmoreland, m. Margaret Stafford
Joan Plantagenet m. John, Baron Mowbray
Sir Thomas Mowbray, Duke of Norfolk, m. Elizabeth Fitz-Alan
Margaret Mowbray, Duchess of Norfolk, m. Sir John Howard
Sir John Howard, Duke of Norfolk
Catherine Howard m. Sir John Bourchier, Lord Berners
Joanne Bourchier m. Edmund Knyvet
Anne Knyvet m. Richard Sayer
John Bourchier Sayers m. Marie Lamoral van Egmont
Richard Sears (Plymouth, 1630)
Deborah Sears m. Zachariah Paddock
Zachariah Paddock
Peter Paddock
Bethial Paddock m. David Crosby
Deborah Crosby m. Dr. Hezekiah Hyatt
Mary Louise Hyatt m. Col. Simeon DeWitt Clough
Mary Anne Clough m. Charles Bradbury Kimball
SARAH LOUISE KIMBALL

[3] Through the Edwards-Tyler-Roosevelt line.

## FREDERICK ELDERKIN FARR

In support of my statement that the average New England farmer has as good a claim to royal blood as any house in Europe, I now set forth a characteristic example, one of which adequate records are available to me,—that of Mr. Frederick Elderkin Farr, late of Wethersfield, now of Perry, New York, a worthy man not essentially different from the body of his fellows. And the reader will at once observe that the following series is for a long period identical with that of Washington, Lincoln, and George V.

Robert de Bellomont, Earl of Leicester, m. Isabel de Vermandois
Elizabeth de Bellomont m. Gilbert de Clare, Earl of Pembroke
Richard de Clare, "Strongbow," Earl of Pembroke
Isabel de Clare m. William le Maréchal, Earl of Pembroke
Eve de Maréchal m. William, Baron de Braose
Maude de Braose m. Roger, Baron Mortimer
Edmund, Baron Mortimer
Roger, Baron Mortimer
Edmund Mortimer
Roger Mortimer, Earl of March
Edmund Mortimer, Earl of March
Elizabeth Mortimer m. Sir Henry Percy, "Hotspur," Earl of Northumberland
Henry Percy, Earl of Northumberland
Margaret Percy m. Sir William Gascoigne
Elizabeth Gascoigne m. Gilbert de Talboys
Sir George de Talboys
Anne de Talboys m. Sir Edward Dymoke
Arthur Dymoke
Edward Dymoke
Thomas Dimmock (Barnstable, 1640) m. Ann Hammond
Shubael Dimmock m. Joanna Bursley
Thankful Dimmock m. Edward Waldo
Edward Waldo m. Abigail Elderkin
Zachariah Waldo m. Elizabeth Wight
John Elderkin Waldo m. Beulah Foster
Anne Waldo m. David Hawley
Diantha Hawley m. Samuel Farr
FREDERICK ELDERKIN FARR

### 2

But by way of cumulative evidence on the origin of the Puritan farmer, I herewith present a second Farr line, this one leading back to Ada de Warren, youngest child of Isabel de Vermandois.

William de Warren, Earl of Warren and Surrey, m. Isabel de Vermandois
Ada de Warren m. Henry of Scotland, Earl of Huntingdon
Margaret de Warren m. Humphrey de Bohun IV, Earl of Hereford and Essex
Henry de Bohun
Humphrey de Bohun V, "the Good," m. Matilde Exouden
Humphrey de Bohun VI m. Eleanor de Braose
Humphrey de Bohun VII m. Maud de Fiennes, descendant of Hugh Capet and of Charlemagne
Humphrey de Bohun VIII m. Elizabeth de Plantagenet, Countess of Holland, daughter of King Edward I and Eleanor of Castile
Lady Margaret de Bohun m. Sir Hugh de Courtenay, Earl of Devon

Edward Courtenay, Earl of Devon, m. Emiline D'Auney
Sir Hugh Courtenay m. Maud Beaumont
Margaret Courtenay m. Sir Theobald Grenville
Sir William Grenville m. Philippa Bonville
Thomas Grenville m. Elizabeth Gorges
Sir Thomas Grenville m. Elizabeth Gilbert
Sir Roger Grenville m. Margaret Whitleigh
Amy Grenville m. John Drake
Robert Drake m. Elizabeth Prideaux
William Drake m. Philippa Denys
John Drake, of Windsor, Conn. (Boston, 1636) m. Elizabeth Rogers
Elizabeth Drake m. John Elderkin
John Elderkin, Jr., m. Abigail Fowler
Colonel John Elderkin m. Susannah Baker
Abigail Elderkin m. Edward Waldo, Jr.
Zachariah Waldo m. Elizabeth Wight
John Elderkin Waldo m. Beulah Foster
Anne Waldo m. David Hawley
Diantha Hawley m. Samuel Farr
FREDERICK ELDERKIN FARR

3

Another series of records[4] carries Mr. Farr's line still farther back to the very beginnings of royalty in both England and France, a conspicuous lineage which, however, if all the facts were known, would be seen to be shared by most Englishmen and Americans.

Egbert of Wessex, first King of England, m. Lady Radburga
Ethelwulf m. Lady Osburga
Alfred the Great m. Lady Alswitha
Alfritha m. Baldwin II, King of Jerusalem, great grandson of Louis le Debonaire, son of Charlemagne
Arnolph I, Count of Flanders, m. Adela de Vermandois
Baldwin III, Count of Flanders, m. Mathilde of Savoy
Arnolph II, Count of Flanders, m. Rosalie d'Ivrée
Baldwin IV, "le Barbu," Count of Flanders, m. Ogive de Luxembourg
Baldwin V, the Pious, Count of Flanders, m. Adela of France
Mathilde m. William I, the Conqueror
Henry I, Beauclerc, m. Maud of Scotland
Mathilde d'Anjou m. Geoffroy Martel Plantagenet
Henry II m. Eleanor D'Aquitaine
John, King of England, m. Isabella de Taillefer, daughter of Aymar de Taillefer and Lady Alice de Courteney
Henry III (1216) m. Eleanor de Berenger of Provence
Edward I m. Eleanor of Castile, daughter of Ferdinand III, San Fernando Rey d'España
Elizabeth Plantagenet m. Humphrey de Bohun VII
Margaret de Bohun m. Hugh de Courteney, Earl of Devon
Edward Courteney m. Emeline D'Auney (Dawney)
Sir Hugh Courteney m. Maud Beaumont
Margaret Courtenev m. Sir Theobald Grenville
Sir William Grenville m. Philippa Bonville
Thomas Grenville m. Elizabeth Gorges
Sir Thomas Grenville m. Elizabeth Gilbert
Sir Roger Grenville m. Margaret Whitleigh
Amy Grenville m. John Drake
Robert Drake m. Elizabeth Brideaux
William Drake m. Phillippa Denys
John Drake (Boston, 1636) m. Elizabeth Rogers
Elizabeth Drake m. John Elderkin
John Elderkin m. Abigail Fowler

[4] Drawn from the extensive compilations of my brother-in-law, the late Edward J. Edwards.

Abigail Elderkin m. Edward Waldo
Zachariah Waldo m. Elizabeth Wight
John Elderkin Waldo m. Beulah Foster
Ann Waldo m. David Hawley
Diantha Hawley m. Samuel Farr
FREDERICK ELDERKIN FARR

I now cite a few more of the leading American descendants of Isabel de Vermandois, surnames only being given. (It is understood, of course, that a change in surname indicates descent through a daughter whose children carry the father's name.)

NATHANIEL BACON: Bellomont, de Clare, Meschines, Bacon for six generations, Thorpe, Bacon again for nine generations.

PHILLIPS BROOKS: Bellomont, de Clare, Maréchal, Mortimer, Percy, Gascoigne, Markenfield, Mauleverer, Kaye, Saltonstall, Cotton, Brown, Brooks. Francis Parkman and Edward Everett also go back to the same (Brooks) group.

WILLIAM ELLERY CHANNING: Bellomont, de Quincy, Zouche, de Vere, Grey, D'Arcy, Dighton, Woodbridge, Remington, Ellery, Channing.

GEORGE DEWEY: Bellomont, DeQuincy, Umfraville for six generations, Lambert, Lyman for seven generations, Dewey for eight generations.

CHARLES WILLIAM ELIOT: Bellomont, DeQuincy, Ferrers, Berkeley, Pynchard, Bassett for eleven generations, Deighton, Dudley, Atkins, Eliot.

ULYSSES SIMPSON GRANT: Bellomont deClare, Maréchal, Braose, Mortimer, Beauchamp, Minor, Clinton, Booth, Grant. The same series leads from Grant through Marsh-Watson to Richard H. Dana.

BENJAMIN HARRISON: Lineage identical with that of Lee except for the last surname.

PATRICK HENRY: Bellomont, deClare, Sutherland, Sinclair, Stuart, Robertson, Henry.

OLIVER WENDELL HOLMES: Bellomont, de Quincy, Zouche, de Vere, Grey, D'Arcy, Yorke, Dudley, Bradstreet, Wendell, Holmes—a line duplicated by that of Wendell Phillips up to the last surname.

THOMAS JEFFERSON: Bellomont, de Quincy, Zouche, de Vere, Isham, Randolph, Jefferson.

J. PIERREPONT MORGAN: Warren, Newburgh, Mauduit, Beauchamp, Plantagenet, Percy, Somerset, Vaughan, Morgan for eleven generations.

JOHN DAVISON ROCKEFELLER: Warren, Newburgh, Mauduit, Beauchamp, Plantagenet, Percy, Neville, Brooks, Wyatt, Pole, Hastings, Clinton, Humphrey, Palmes, Avery, Rockefeller.

WILLIAM THOMPSON SEDGWICK: Bellomont de Clare, Maréchal, Braose, Mortimer, Beauchamp, Cavendish, Pierrepont, Edwards, Dwight, Sedgwick.

Two generalizations stand out in studies of this kind; first, that of the boundless range of combinations possible from the same essential traits or "unit characters"; second, the gradual rise in importance of the self-respecting middle class which slowly but surely develops at the expense of those artificially maintained as master or serf under the caste system. As to the first, each is the sum of his own combination of developed unit characters. Never yet were any two people exactly alike; Nature has infinite variety at her disposal. Among all these combinations, one, here and there, spells true distinction, and from humble (though never feeble) ancestry spring many of our greatest, "the elements so mixed in them" that the blend is especially favorable. For originality rests not on new traits but on new adjustments of the old.

# STUDIES IN INFANT PSYCHOLOGY[1]

By Dr. JOHN B. WATSON and
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AT no previous time in the history of the human race has so much interest centered in the life and growth of the infant. One sees evidence of this in the development of various organizations and institutions for furthering the bodily welfare of the child; in the fact that kindergartens are admitting younger and younger children; and in the fact that the whole field of preventive medicine is focusing more and more upon the study of methods by means of which the infant and the child may be kept free from disease. At a recent conference of physicians and psychologists held for the purpose of discussing the feeding and the care of infants and their medical and psychological study, the remark was often made, albeit somewhat grudgingly, "it seems astonishing but true that everything in the last three years in medicine and psychology has been headed toward the infant." From the moment of birth and even before his advent the young human animal is looked after from every material standpoint in a way which would have made our frontier ancestors, who simply let their babies grow, doubt our sanity.

The conviction is growing, however, and rapidly, that our knowledge is still too scanty to enable us to care properly for all phases of the welfare of the infant and child. Pediatricians, dieticians and even general practitioners have had the conclusion forced upon them that merely keeping the bottle plentifully supplied with modified cow's milk or feeding the infant with some new form of "balanced diet" combined with a little welfare work in the home, has not prevented a

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The work at Hopkins was left in such an incomplete state that verified conclusions are not possible; hence this summary, like so many other bits of psychological work, must be looked upon merely as a preliminary exposition of possibilities rather than as a catalogue of concrete usable results.

high rate of infant mortality. Nor have we any guarantee even if the body weight is kept normal by any form of diet other possibly than the mother's milk that the infant will develop properly along psychological lines. And by psychological in this connection we mean the plain matters of common occurrence such as crawling, walking, sitting up, beginning to speak, smiling, blinking, reaching, imitation, the putting on of habits, the expression of emotional activity, and the like. It lies very well within the bounds of possibility that a diet and régime which will keep up the body weight might nevertheless cause an infant to put on its various necessary activities at a very slow rate or possibly at a too rapid rate. This might end in giving us either a child or an adult with a very unbalanced and unstable disposition or an indolent or phlegmatic one. Research work along many lines—nutritional, glandular, the effects of difficult labor, inheritance, and the psychological study of infant activity—is called for from our best qualified men.

On the psychological side our present knowledge of infant life is almost *nil.* If an anxious mother wishes to determine whether her infant is developing normally along psychological lines there are no data at present to guide her and no individual or institution to whom she may turn to get a reasonable answer. Who would pretend to say what the activity chart or stream of activity of a three months', six months' or year old child should reveal? The ordinary doctor will say, "Don't worry about the infant, it is getting along all right. Anyway it is too young for anybody to tell much about it." Nor is this let-alone policy confined solely to the general practitioners. Even our educators do not escape it. A prominent professor of education once said to us, "You will find when you have taught as many children as I have that you can do nothing with a child until it is over five years of age." Our own view after studying many hundreds of infants is that one can make or break the child so far as its personality is concerned long before the age of five is reached. We believe that by the end of the second year the pattern of the future individual is already laid down. Many things which go into the making of this pattern are under the control of the parents, but as yet they have not been made aware of them. The question as to whether the child will possess a stable or unstable personality, whether it is going to be timid and beset with many fears and subject to rages and tantrums, whether it will exhibit tendencies of general over or under emotionalism, and the like, has been answered already by the end of the two year period.

There are several reasons why the minute psychological study of infant life is important. (1) As was pointed out there are no standards of behavior or conduct for young infants. Our own experi-

mental work which, even at the end of two years is just beginning, has taught us that the study of infant activity from birth onward will enable us to tell with some accuracy what a normal child at three months of age can and should do and what additional complexities in behavior should appear as the months go by. Psychological laboratories in many institutions ought to be able to make cross-sections of the activity of any infant at any age and tell whether the streams of activity are running their normal course and whether certain ones are lagging or have not even appeared. After sufficient work has been done to enable us to have confidence in our standards we should be able to detect feeble-mindedness, deficiencies in habit, and deviations in emotional life. If a proper analysis of the activity streams can be made at a very early age the whole care of the child may be altered with beneficial results. (2) Modern psychology catalogues most elaborate lists of instincts and emotions in human beings. These catalogues are not based upon experimental work but upon the preconceived opinions of the men making up the lists. At present we simply have not the data for the enumeration of man's original tendencies and it will be impossible to obtain such data until we have followed through the development of the acitvity of many infants from birth to advanced childhood. Children of five years of age and over are enormously sophisticated. The home environment and outside companions have so shaped them that the original tendencies can not be observed. The habits put on in such an environment quickly overlay the primitive and hereditary equipment. A workable psychology of human instincts and emotions can thus never be attained by merely observing the behavior of the adult. (3) By reason of this defect the study of vocational and business phychology is in a backward state. The attempt to select a vocation for a boy or girl in the light of our present knowledge of the original nature of man is little more than a leap in the dark. High sounding names like the constructive instinct, the instinct of workmanship and the like, which are now so much used by the sociologists and the economists, will remain empty phrases until we have increased our knowledge of infancy and childhood. The only reasonable way, it would seem to us, of ever determining a satisfactory knowledge of the various original vocational bents and capacities of the human race is for psychologists to bring up under the supervision of medical men a large group of infants under controlled but varied and sympathetic conditions. Children begin to reach for, select, play with and to manipulate objects from about the 150th day on. What objects they select day by day, what form their manipulation takes, and what early habits develop upon such primitive instinctive activity should be recorded day by day in black and white. There will be marked individual differences in the material selected, in the length of

time any type of material will be utilized, and in the early constructive habits which will arise with respect to all materials worked with by the infant. Without instruction one infant (eighteen to twenty months in an observed case) will build a neat wall with her blocks, with one color always facing her. If the block is turned while she is not looking she will quickly change it and correct the defect. In other children such a bit of behavior can be inculcated only with the greatest difficulty. Still another child can not be made to play with blocks but will work with twigs and sticks by the hour. Variations in the election and use of materials are the rule in infancy but until we have followed up the future course of such variations upon *infants whose past we have watched day by day* we are in no position to make generalizations about the original tendencies which underlie the vocations. (4) Finally, until we have obtained data upon the emotional life of the infant and the normal curve of instinctive and habit activity at the various ages, new methods for correcting deviations in emotional, instinctive and habit development can not be worked out. Let us take a concrete example. A certain child is afraid of animals of every type, furry objects, the dark, etc. These fears are not hereditary. Our experiments will be convincing upon that point. What steps can we take to remove these fears, which unless they are removed in infancy, may become an enduring part of the child's personality?

Fears in personality

## An Experimental Study of what Infants can do at Different Ages. Instincts and Early Habits

The human infant in general is sturdy and well able to stand all of the simple tests we need to apply. Certainly the stresses and strains upon his nervous system, the muscular pulls and twists he gets in merely being born are a thousand times harder upon him than anything we will later do to him in the laboratory. Probably none of our tests is any more strenuous for him than giving him his morning bath or changing his clothes. We have worked upon more than five hundred infants and so far without the slightest temporary or permanent mishap. These remarks seem necessary in view of the fact that sentimentalists sometimes feel when visiting our laboratory that our work may be a little hard on the infant. The work is done under the constant supervision of physicians and we take the stand that what we are doing will be important in the long run in lessening human misery and maladjustment.

When the newborn infant is first brought into the laboratory and undressed most visitors exclaim: "What can you see to study in that highly unstable but wholly delightful bit of helpless protoplasm?" Observation does seem all but hopeless at first. But closer inspection soon makes it clear that there are many forms of infant adjustment which can be studied easily under controlled experimental conditions.

Our first problem in the psychological study of the infant was the finding out of those activities that can be seen at birth and those that appear as the infant increases in age. Which among those activities drop out or change as age advances? What is the significance for the later make-up of the individual of those that remain in the stream? How are they tied together so as to form suitable bases for the putting on of the stable and constructive habits of the adult? We can possibly present our problem and our methods by considering a few of the activities as they appear under laboratory scrutiny.

*Grasping.* One of the easiest things to note about the new born human infant is that when any small object such as a stick, a tuft of hair, or a finger is placed in the palm, its fingers close down upon the object and clasp it tightly. For experimental purposes we used a small twisted wire rod covered with a piece of rubber tubing. The infant's fingers are open, the rod is placed in the palm and a gentle shake administered, whereupon its grasp of the rod tightens. The experimenter then catches the two ends of the rod and raises the child up over a soft mattress. One assistant takes the time that the infant hangs suspended while a second assistant puts both hands under it to catch it when it lets go. The evidence seems to be good that all but about two per cent. of normal infants of average weight at birth can suspend themselves for an appreciable interval of time. Many of them will hang suspended for only a fraction of a second while others will hang suspended for many seconds. The longest suspension we have had was one minute. Often times the infant is made to suspend itself with difficulty. In such cases it is emotionally aroused by holding the head, feet or legs or by holding the nose for an instant. If a good healthy cry is started the muscular strength seems to be increased. Whether this bears out Cannon's contention that the major emotions such as fear and rage are biologically serviceable can possibly not be concluded from these experiments. His view is that under the influence of stimuli that produce the major emotions a greater than normal amount of adrenalin is set free by the adrenal glands (one of the so-called ductless glands). This adrenalin attacks the stored sugar in the liver (glycogen) setting it free in the blood stream in such a form that it can serve rapidly as food for the muscles and for neutralizing fatigue products in the muscles. At any rate the fact remains that in many cases when the sluggish infant can be stirred up emotionally it can be made to suspend itself on the rod.

This instinctive reaction undoubtedly begins before birth since it is present in children born prematurely. We have followed it through day by day on a great many children. The daily time of suspension varies greatly. It does not seem to increase or decrease with the age of the child in any regular way. The most significant fact for the

work we are engaged in is that the instinct disappears at about the age of one hundred and twenty-four days, although in some infants it persists to a greater age. Once it disappears from the stream of activity under normal conditions it never returns. It will be seen here at once that this observation of the grasping instinct gives us one of our desirable points. If we take a cross-section of the activities of the child at any time from birth to one hundred and twenty-four days, we shall find this instinct present. After the period of its disappearance, not yet exactly determined, the behavior of the infant would give no evidence that such an instinct had ever been present. Having determined what is called a normal distribution curve for the disappearance of this instinct in normal children, it will be seen that we have a basis or standard for testing infants whose development seems to be delayed; for example, comparing with presumably normal infants, infants whose parents are feeble-minded, since we know that a large percentage of the infants of feeble-minded parents will turn out to be feeble-minded. We are not yet ready to advise the practical use of this test. Our work progressess slowly by reason of the fact that normal infants suitable in age are difficult to obtain in the laboratory and infants suspected of abnormality are still more difficult to obtain. What slender evidence we have would seem to show that in these suspected cases this primitive instinct persists for a much longer time than it does in the supposedly normal infants. A word of warning should be introduced here in order that mothers may avoid needless anxiety in case they find that their infants possess the grasping instinct at a much later age than we have indicated as being the usual one. Our work has not gone far enough for us to say that even if the instinct is present at one hundred and seventy-five days of age the infant must necessarily be abnormally slow in development. One should not draw any conclusions on the basis of either the presence or the absence of any one such hereditary form of activity. It is only when we have established workable standards for many such modes of behavior and find deviations from these norms in many particulars that alarm need be felt.

*Reaching.* As soon as the grasping reflex begins to disappear a much more serviceable form of activity, partly hereditary and partly *learned* (habit), begins to take its place, and that is extending the hand for an object, grasping it, and carrying it to the mouth or manipulating it. This is probably the most fundamental group of activities appearing in man. Tests for reaching are begun at one hundred days of age. The subject is seated in the lap of an assistant in a well lighted room. The experimenter takes a stick of candy and slowly extends it toward the infant. After the lips have been touched with the candy several times the sight of it, even before the reaching stage is attained, will

tend to bring about heightened activity, especially of the hands. As the days go by this activity becomes greater and at one time or another the experimenter will find, if his patience is sufficient, that the infant will slap the inside of the palm against the candy, will grasp it and carry it towards the face. When this happens the subject is always allowed to suck the candy for just an instant. The candy is then removed and the test repeated. Five or six such tests are given on each weekly experiment. The growth of this combined instinct and habit activity is extremely instructive to watch. In normal infants at one hundred and fifty days who have had weekly practice for several weeks the reaction is fairly definitely established. At that time almost any object will be reached for. One of the most significant factors appearing is that apparently the infant is positive to all objects, that is it reaches out for practically every object and avoids none. With slight exceptions all avoiding reactions, that is drawing back or turning from objects, have to be learned. This can be illustrated very nicely with the lighted candle. We usually establish the reactions of reaching for the candy and avoiding the candle flame at the same time. If the candle is made to approach the infant's face the same eager random activity is exhibited as to the candy. Care is taken always not to allow the hand to come close enough to produce a burn. But the hand is allowed on every trial to be momentarily touched by the flame. This produces a slight reflex withdrawal of the finger, sharp closing, fanning or spreading of the fingers, etc., and, if the temperature is too great, an actual reflex withdrawal of the arm. The candle is then hid for a moment and the child again stimulated. The growth of this activity is very similar to that of reaching for the candy. It takes not one slight burn of the candle but many before the infant learns to let its hands hang at its sides when the candle gets within reaching distance. Possibly if the burn were made severe enough only a few such tests would be required (a "conditioned reflex" would arise instead of the ordinary habit).

candy
&
candle

Another feature of the reaching reaction has been worked out and that is the distance to which the child will reach for objects. When we started our studies we believed with the poet that the child would reach for any object coming within its ken regardless of the actual distance of the object. Much to our surprise we found that in no case were objects reached for, even when fixated and followed with the eyes, at a greater distance than twenty inches. When a lighted candle is brought slowly across the room and extended toward an infant which has just learned to reach, the hands and arms do not begin to get active until the candle is twenty-five inches from the face. The body then begins to bend toward the object and finally as it is brought nearer still the hands and fingers take on the proper adjustment for grasping; actual reaching then soon follows.

We thus see that in the study of reaching we obtain another point on our infant activity chart. An infant tested at one hundred and fifty days should have as a part of its equipment the ability to reach for objects, to grasp them and to carry them to the mouth or otherwise manipulate them, and the ability to learn to avoid a candle or other harmful stimuli provided proper training has been instituted.

*Right- and Left-handedness.* At the present time a good deal of interest is manifested in the question as to whether handedness is hereditary or whether it is simply a learned response. The discussion so far has been of the "arm chair" variety. Most individuals are right-handed and it is natural to suppose that we would try to instil in youngsters almost from the beginning the dominance of the right hand. We bring this about possibly even without trying to by handing objects toward the child's right hand, by shaking its right hand, patting its right hand, and by leaving its right hand free in carrying it in our arms. Does this behavior on our part simply carry on right-handedness traditionally or is there something hereditary and instinctive about this reaction? The problem is both an interesting one scientifically and at the same time a practical one since it cuts deep into actual school procedure. All children are told when they come to writing, "Now take your pencil in your right hand." We do not wish to criticise such a custom in the light of our present knowledge. We know that most children thrive more or less well under such a procedure. On the other hand there is a slight but growing body of evidence to show that in some children at least stammering and other emotional mishaps may result when a child has for whatever reason predominantly used its left hand and has been forced to change over to the right. In some cases the bad symptoms disappear if the child is allowed to go back to the free use of its left hand.

We have carried through a rather wide series of studies, not yet completed, however, upon the problem of handedness. Our thesis for the moment is: If the predominant use of one hand is an instinctive and hereditary matter from birth onward, it would be better to let the child learn to use the hand in line with its instinctive endowment. On the other hand if no such instinctive factor is present it would be less embarrassing for the child in most situations if it were forced to use the right hand. In order to test this matter we made a careful study upon twenty infants of the length of time they could hang suspended with the right and left hands. Each of the infants was brought into the laboratory at birth and each day thereafter for a period of ten days and tested. Our results show conclusively that the infant does not suspend itself on the average with the right hand for a longer time than with the left. As a matter of fact the total time of suspension for the ten days was exactly the same for the two hands.

[illegible] by suspension no difference

In order to make our results more conclusive still we devised a small "work adder" by means of which the random slashing movements of the infant could be recorded. A cord is attached at one end to the infant's wrist and at the other to a small escapement device which when operated caused a toothed wheel to revolve always in one direction. To the toothed wheel is connected a small drum. A cord bearing a small lead weight is fastened to the drum. As the infant makes its random movements this weight is wound higher and higher from the ground. Such an apparatus is of course attached simultaneously to each wrist. At the end of five minutes the experiment is stopped and the height to which the weights have been wound up from the floor is measured. The same twenty infants whose grasping reflex was tested were used in this experiment. This method gave us abundant opportunity to determine experimentally whether one hand was used more than the other. Our results show that the amount of work done on the work adders is almost identically the same for the two hands (the difference is less than P. E.) if the work of the two hands for the whole ten days is averaged. On any one day there was a disparity in the amount of work done with the two hands, but an infant markedly right-handed today is just as likely to be left-handed tomorrow.

One other step has been taken in the attempt to settle the problem of handedness. Infants from about one hundred and fifty days to one year of age have been tested once each week to find out which hand was first used in reaching for objects. On each weekly test from ten to twenty trials were given. A stick of peppermint candy or a candle was generally used as a test object. The object was brought slowly toward the face of the infant. At the proper distance reaching finally occurred. An assistant recorded on each trial the hand first used and if both hands were used, as was often the case, which one first touched the object. Again our tests fail to show any predominant use of either hand. So that we must conclude, albeit tentatively, that there is yet no evidence for assuming a hereditary basis for handedness.

This result seems to be confirmed by the anatomical measurements we have recently made (so far upon only one hundred infants). The length of the forearm to the tip of the middle finger is measured very accurately with a device which resembles somewhat the instrument that is used for measuring the length of the foot in shoe stores. The breadth of the wrist likewise is measured with calipers and the width of the palm at the knuckles. In these one hundred cases, which we admit are too few for any certain conclusion, we find almost no difference betwen right and left measurements.

*Early Eye Movements.* This excursion into the field of our studies upon right-and-left-handedness has taken us a little aside from our main problem which was to show the course and development of those

instinctive movements which will yield us an activity chart. Early eye movements furnish us with at least three definite new points on this chart. The eye movements of the infant are not difficult to study. The infant is placed upon its back with the face held lightly in a vertical position by the observers. Immediately above the baby's head is suspended a perimeter carrying a small light. This perimeter looks like the half of a barrel hoop. The light is thus always equi-distant from the baby's eye. It can be made to appear first on the left side and then on the right. We start with it usually on the left. In a second or two after the light is turned on the infant's eyes swing to the lighted side. There is no fixation in the strict sense of the word but all of the roving movements of the eyes take place in the lighted field. As soon as the eyes have swung over the light is turned out, shifted to the right and again lighted. In a few seconds the eyes swing slowly over to the right. This reaction seems to take place with the same regularity as do the responses to light of lower organisms. Indeed, we have called it the tropism-like response of the human eye. This reaction takes place equally well but more slowly if one eye is screened from the light. At a fairly definite time, which we are not yet ready to state, this response seems to disappear and something corresponding to definite fixation occurs. At that later age the infant begins to focus upon objects. To test this second type of eye movement the infant is placed in a sitting position on an attendant's lap. A lighted candle is then moved to the right side and then over to the left, then up and then down in straight lines. Its eyes fixate the candle and move with it but do not follow the light if it is rotated in a circle. This is the second stage in the development of eye responses. When the candle is held to the right or left, fixation is easier to obtain than when it is placed above or below the eyes. Again fixation is easier to obtain when the candle is held above the eyes than when it is held below them. The third stage is what we have called complete fixation; it occurs, let us say tentatively, around the one hundredth day. The eye of the infant is then able to follow a candle when it is moved in a complete circle. It is worth noting in passing that very few children are born with badly crossed eyes. Occasionally we do find one with the muscular balance so poor that the early tropism response is hard to obtain.

*The Babinski Reflex.* If the sole of the foot of a normal adult is stroked with the end of a match all five toes show flexion, that is, the toes bend downward toward the ground. On the other hand, in certain pathological cases where there is a lesion in the central nervous system a new type of response appears. When stimulated by the match stick the great toe, instead of showing flexion, shows extension, that is to say, flies upward. The other toes usually spread out like a fan or show the normal flexion described above. This is usually known as the

"sign" or reflex of Babinski. Its presence in the adult is definitely pathological. Strange to say the infant exhibits this reflex. Apparently its presence is due to the fact that there is a lack of complete development of one of the tracts in the central nervous system. It would seem at first sight that its study would give us one of our safest criteria in determining what one might call the activity or developmental age of the child as opposed to its chronological age, since its disappearance does apparently mark the completion of the growth of certain structures in the nervous system. Such seems not to be the case, however. It is a most variable type of response. We have made many hundreds of tests on children from birth to three years of age. In rare cases it is absent from birth. In certain other cases it can be obtained in one foot and not in the other. Sometimes it can be obtained on one day and not on the next. Again it disappears at a very variable age. It is ordinarily said that the Babinski reflex disappears around six months of age. Here are a few actual figures:

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| 0 to 3 months, | 24 cases observed, | present in 21 cases, | absent in 3 |
| 4 to 6 months, | 8 cases observed, | present in 6 cases, | absent in 2 |
| 7 to 12 months, | 12 cases observed, | present in 7 cases, | absent in 5 |
| Over 1 year, | 6 cases observed, | present in 1 case, | absent in 5 |

These do not represent all of our results but merely those obtained from a rather homogeneous group. The indication on these few cases is that it is absent or approaches senescence at one year of age or thereabouts. It would thus seem that the Babinski can never be used as any safe kind of guide in determining the normal activity age of infants. Nevertheless if it persists to a much greater age than one year one should want to make a pretty thorough examination of the whole reflex and instinctive equipment.

*Sitting Alone.* The ability to sit alone is an extremely important index of development, comparable probably in all respects to reaching. In order to study progress in this act the infant is placed in a sitting position on a hard mattress with legs outstretched at a given angle. Tests are usually begun at about one hundred days of age. We give below the progress of one infant. The first evidence that sitting alone was possible was obtained at 138 days. She fell over in 2 minutes and 12 seconds to the right side. It was found that if the infant was stimulated by holding some object in front of her or by getting the mother to cause her to smile and reach out her hand the sitting position could be maintained for a longer period of time than if she were left alone. On the 150th day, while the infant did not sit up for a longer period of time, she began to pull at her sock, leaned over and touched the foot with nose and mouth, and looked around, sitting up the while. On the 159th day she sat up steadily, played with her toes, used the hands in striking the mattress, then gradually sagged forward, drop-

ping at the end of 4 minutes. She was making steady progress in this response when one day at home, while sitting alone, she fell over backward and struck her head on a stone, producing a coma-like state which lasted for an hour and a half. This one experience markedly delayed her progress in sitting alone. We have noticed the same thing when children are learning to stand and to walk. If the child has a fall or a mishap while standing it is likely to cry when again placed in a standing position and almost immediately begin to "feel" its way to the ground without attempting to put forth the best that is in it. While our records are few we should say that most infants so far studied are able to sit up for a short length of time at the age of six months.

The types of infant behavior so far discussed serve simply to illustrate the purpose and methods of our work. The development of many other instinctive activities is being followed through. We can only briefly indicate some of them. The early defensive responses of children can be quite readily observed. If one pinches slightly the inside of the right knee the left foot is drawn upward and will begin to push at the offender's hand. If the nose is held the hands are thrust upward and strike at the obstructing object. In normal youngsters these responses are quick and active. They are present from birth and persist throughout life. Again, in infants the thumb is useless and lies folded across the palm. At about one hundred days of age in normal infants it can be brought parallel with the forefinger; a little later it can be used like the other fingers in grasping and takes the adult position when the hand and fingers are extended. Blinking is another activity which has a partly defensive function. This response can be obtained by passing the hand or other object rapidly across the baby's eyes and between the eyes and the source of light. Care must be taken to keep from touching the eyebrows or creating a draft of air. Unless these precautions are taken we can obtain blinking from birth; but blinking due to a rapid shadow passing across the eyes can not be obtained earlier than the sixtieth day. In many supposedly normal infants it can not be elicited before the one hundred and twentieth to one hundred and fiftieth day. Crawling is another most important function. Progression of some kind is undoubtedly instinctive, but the form that the progression takes differs markedly in every child and probably depends upon a lack of balance in structural development and partly upon habit factors. Some infants make progress by springs and dives when the leg and waist muscles are well developed. When the arm muscles are better developed progression takes place by using mainly one or both elbows, and if one arm is weaker than the other the child moves in a circle. By degrees, however, it learns to compen-

sate for this and to make progress even though one arm remains weak. As a forerunner of the ability to stand alone and walk one must observe week by week the development of the "extensor thrust" of the leg. At a certain age, which we are not yet ready to fix exactly, this reflex appears. It is easy to observe. Place the infant on its back, take hold of the two hands and pull it slowly to a sitting position and then gradually upward. As soon as any part of the sole of the foot touches the mat a noticeable stiffening of the leg appears and as the whole weight of the infant is borne by the feet the legs suddenly stiffen and take the whole load. In backward children it is unquestionably delayed; in some cases the reflex can not be brought out in children even three and four years of age.

This almost random sampling of our laboratory studies on the instinctive and habit activities of infants teaches us first that there is a wealth of material to observe and study in the infant at every age and that as this material is worked up it becomes useful from both the scientific and the practical standpoint, in the latter case enabling us to tell when an infant, whatever its régime or diet, is progressing properly on the activity side.

Most of our work has been done upon subjects under ten months of age. Observations which we are just beginning on older infants show that here is a very rich and promising field of work in the period lying between ten and twenty-four months. Imitation of varied kinds appears, spoken language begins, standing and walking develop, and then the whole world of objects is examined by the child under his own steam. Here become more marked and complex the varied activities which most immediately show what, for lack of a better term, we may call personality. It is here that we expect to find most of our data on the human being's repertoire of instincts and vocational bents. Again, during this period we shall have our best opportunity for studying methods by means of which we can shape the early habits along desirable lines, socialize the instincts, break up harmful emotional attachments and stabilize the whole of the general system of emotional expression. The second year of childhood development is from our standpoint the one most fraught with possibilities of mishap along emotional lines. For an understanding of the infant's emotional life and how emotional expression becomes linked up with the instinctive and habit activities such as we have just examined, it seems best to turn once more to the laboratory.

## Experimental Study of the Emotional Life of Infants

The experimental study of the emotions in adults is in a backward state in psychology. For one reason, emotions seem too evanescent and

too complex for study. They run all the way in complexity from the simple blush of the boy or girl to the violent states we see in love and rage in which the individual is totally unfitted to carry out his ordinary activities. Early in our study of the emotional life of the infant we came to the conclusion that in them the emotional patterns are really quite simple and that the later complexity we see in the adult is brought about by training and environmental influence. But this training has been of an accidental character and under the control neither of the person in whom the emotion was built up nor of his parents and other associates. It seemed worth while to test out this hypothesis experimentally because it is important to bring the emotional life under some kind of scientific and practical control and to do this we must study how the early environment of the child forces emotional states upon him. Such a study it was hoped might result in a practical procedure by the use of which the child's life might be so shaped that undesirable emotions might not be implanted. On the other hand, granting that they had been implanted through carelessness or ignorance of parents and associates, we hoped to find methods by means of which they could be got rid of.

Our earliest observation showed that from birth three fundamental inherited emotional patterns could be observed. Without assuming that our observations are complete we feel reasonably sure that *fear*, *rage* and *love* are original and fundamental. Our method of observing these emotions is a purely behavioristic one, that is, we make no effort to read into the mind of the child those things which psychologists have attempted to do for so long. We bring the child into the laboratory and stimulate it with those objects which we know will produce emotion in many adults and in nearly all children who have had the ordinary home bringing up. We then note the reaction that takes place. In other words, in any bit of behavior which can be observed there is always a stimulus or object present which calls out a reaction. The psychologist, then, must search for the objects which will call out emotions and then observe the reactions to each so that new forms of emotional expression may be found. We will apply this simple procedure to the infants brought up in the sheltered environment of the hospital where contact with the outside world has been kept at a minimum.

*Fear*. What are the stimuli (objects or situations) which will bring out fear responses in infant ? Our observation shows that the stimuli to fear are quite constant and quite simple. If the infant is held over a pillow and allowed to drop suddenly, the fear response appears. It can be brought out generally by a sudden shake or push or by suddenly pulling the blanket upon which it is lying. We might

group all of these and say that *sudden removal of support* is an adequate stimulus to fear. The other most far reaching and important stimulus is that of a *loud sound;* for example, the striking of a long steel bar with a hammer is one of the most effective means of calling out this response. These are the common stimuli which are present almost daily in the life of every infant. The reaction or response to such stimuli is a sudden catching of the breath, clutching randomly with the hands, the sudden closing of the eyes, and the puckering of the lips followed in some cases by crying. In older children these reactions appear and in addition there is crawling away, running away and in some cases hiding the face. We have found no other stimuli which will call forth fear in the very young infant. It has been often stated that children are afraid of the dark, or animals, of furry objects in general. We shall show later that this is not the case.

*Rage.* In a similar way we have studied the question as to the original objects and situations which will produce the response of rage. Our observations show conclusively that the *hampering of the infant's movements* is the one stimulus which apart from all training brings out the movements we should characterize as rage. If the head is held lightly between the hands, if the arms are held closely to the sides or if the legs are held tightly together the response appears. The body stiffens and if the arms are free slashing movements of the hands and arms result. If the legs are free the feet and legs are drawn up and down, the breath is held until the child's face is flushed. There is crying at first, then the mouth is opened to the fullest extent and the breath is held until the face appears blue. These states can be brought on without the pressure in any case being severe enough to produce the slightest injury to the child. The experiments are discontinued the moment the slightest blueness appears in the skin. Almost any child can be thrown into such a state and the reactions will continue until the irritating situation is relieved and sometimes for a considerable period thereafter. We have had this state brought out when the arms are held upward by a cord to which is attached a lead ball not exceeding an ounce in weight. The constant hampering of the arms produced by even this slight weight is sufficient to bring out the response. When the child is lying on its back it can occasionally be brought out by pressing on each side of the head with cotton wool. In many cases this state can be observed quite easily when the mother or nurse dresses the child especially in winter clothing.

*Love.* The study of this emotion in the infant is beset with a great many difficulties on the conventional side. Our observations consequently have been incidental rather than directly experimental. The stimulus to love apparently is the stroking of the skin, tickling, gentle

rocking, patting and turning the child across the attendant's knee on its stomach; it is especially brought out by the stimulation of what, for lack of a better term, we may call the erogenous zones, such as the nipples, the lips and the sex organs. The response in an infant depends upon its state. If it is crying the crying will cease and a smile may appear. In slightly older children there is a gurgling and cooing and in still older children the extension of the arms which we shall class as the forerunner of the embrace of adults. It is thus seen that we use the term "love" in a much broader sense than it is popularly used. The responses we intend to mark off here are those popularly called "affectionate," "good natured," "kindly," etc. The term "love" embraces all of these as well as the responses we see in adults between the sexes. They all have a common origin.

Whether these are all the emotional patterns that are strictly hereditary and not due to training we are not sure, and whether there are other stimuli which will call out these responses we must also leave in doubt; but if our observations are in any way complete it would seem that the emotional reactions are quite simple in the infant and the stimuli which call them out quite few in number. Our own observations did not at first satisfy us because the whole problem appeared too simple and stereotyped. We determined then to continue with our work along a slightly different line. It was our good fortune to have six or seven older children brought up in the hospital under a strict régime. These children varied in ages from about four months to one year. They had had practically no outside contact with the world, having never left the hospital buildings. They had never seen an animal or any of the objects which were later presented to them in the laboratory. All of these children were extremely well and healthy in view of the fact that they belonged to the wet nurses attached to the hospital.

The infants were brought to the laboratory and seated in the lap of the mother or of an attendant. As soon as the infant became still a hitherto concealed live animal was suddenly presented. We can only illustrate two or three such tests and summarize the general results. For example the following experiment was made upon baby T., a girl, 165 days of age:

A very lively, friendly *black cat* was allowed to crawl near the baby. She reached for it with both hands at once. The cat was purring loudly. She touched its nose, playing with it with her fingers. It was shown three times. Each time she reached with both hands for it, the left hand being rather more active. She reached for it when it was placed on a lounge before her but out of reach.

Then a *pigeon* in a paper bag was laid on the couch. The pigeon was struggling, and moving the bag about on the couch and making a scraping

noise. The baby watched it intently but did not reach for it. The pigeon was taken out of the bag on the couch before her, cooing and struggling in the experimenter's hands. She reached for it again and again and failing, of course, to get hold of it put her hands in her mouth each time. She was allowed to touch its head. The pigeon moved its head about with quick, jerking movements. It was then held by its feet and allowed to flap its wings near the baby's face. She watched it intently, showing no tendency to avoid it, but did not reach for it. When the bird became quiet she reached for it, and caught hold of its beak with her left hand.

*Test with a rabbit.* The animal was put on a couch in front of her. (The child was sitting on her mother's lap). She watched it very intently but did not reach for it until the experimenter held it in his hands close to her; then she reached for it immediately, catching one of its ears with her left hand, and attempted to put it into her mouth.

The last animal presented to her was a *white rat.* She paid little attention to it, only fixating it occasionally. She followed it with her eyes somewhat when it moved about the couch. When held out to her on the experimenter's arm she turned away, no longer stimulated.

*April 24, 172 days old.* The baby was taken into a dark room with only an electric light behind her (faint illumination). A stranger held the baby. The mother sat where she could not be seen. A dog was brought into the room and allowed to jump up on the couch beside her. The baby watched intently every move the dog made but did not attempt to reach for it. Then she turned her head aside. The front light was then turned up and the dog again exhibited. The infant watched very closely every move the dog and the experimenter made, but did not attempt to catch the animal. She exhibited no fear reactions no matter how close the dog was made to come to her.

The tests were continued by taking the child in its chair to the dark room and building a small bonfire in front of it. The final trial with every child was made by taking it to the zoological park and confronting it with many different types of animals, special permission being accorded us for close inspection of the primates.

Never in any experiment on any child was the slightest fear response obtained. Almost the invariable mode of behavior was a reaching for the object, followed by handling or manipulation. Our results seem to show conclusively that when children are brought up in an extremely sheltered environment, such as never is afforded by the home, fears are not present to other stimuli than those which we have already enumerated.

How can we square these observations with those which show the enormous complexity in the emotional life of the adult? We know that hundreds of children are afraid of the dark, we know that many women are afraid of snakes, mice and insects, and that emotions are attached to many ordinary objects of almost daily use. Fears become attached to persons and to places and to general situations, such as the woods, the water, etc. In the same way the number of objects and situations which can call out rage and love become enormously increased. Rage and love at first are not produced by the mere sight of

an object. We know that later on in life the mere sight of persons may call out both of these primitive emotions. How do such "attachments" grow up? How can objects which at first do not call out emotions come later to call them out and thus enormously increase the richness as well as the dangers of our emotional life?

Until recently no experimental work had been done which would show such emotional attachments in the making. We were rather loath to conduct such experiments, but the need of this kind of study was so great that we finally decided to undertake the building up of certain fears in the infant and then later to study practical methods for removing them. We chose as our first subject Albert B., an infant weighing twenty-one pounds at eleven months of age. We chose him particularly because of his stolid and phlegmatic disposition.

Before turning to the experiments by means of which we built up fears in this infant it is necessary to give a brief description of a method which has recently been developed in psychology, that of the "conditioning of reflexes." If a subject sits with the palm of his hand upon a metal plate and his middle finger upon a metal bar and an electrical current is sent through the circuit thus completed by the hand, the finger will fly upward from the metal bar the moment the electric shock is given. This painful stimulus is thus the native or fundamental stimulus which calls out the defensive reflex of the finger. The sight of an apple or the sound of a bell will naturally not produce this upward jerk of the finger. On the other hand, if the bell is sounded or the colored object is shown the moment the electric current is completed through the hand, and this routine is repeated several times, the situation becomes wholly different. The finger begins to jerk up reflexly now and then when the bell is rung or the colored object shown even if the electrical current is not sent through the hand. After a longer or shorter period of training the colored object will cause the jump of the finger just as inevitably as does the current. This we call a conditioned motor response and we have shown that these conditioned responses persist for long periods of time, in some cases possibly throughout the life of the individual. There is no "reasoning" or "association of ideas" involved, because we can produce conditioned reflexes in very low forms of animals. The same thing occurs in our glands. If one attaches a small apparatus to the parotid gland—one of the salivary glands in the cheek—in such a way that the saliva flows out drop by drop, it can be shown that the direct stimulus of the gland is *actual contact* with some edible or drinkable substance, for example, weak hydrochloric acid, vinegar, etc. The moment such an acid touches the tongue the gland begins to flow profusely. Ordinarily the sight of objects does not produce an increased flow of the glands, but if combined stimulations are given, the object being shown at the same time the acid is given, the sight of the object

finally will produce an increased flow of the gland. This is of course what happens every time food or drink is brought to the mouth. Thus the youngster's mouth has every reason to "water" when a stick of candy is held in front of him or our own when we are hungry and a toothsome morsel is held before our eyes. It is probable that all of our glands, even the so-called ductless ones such as the thyroid or the adrenals, become conditioned by means of such environmental factors throughout our life.

We began to question, with such results as the above in front of us, whether or not entire emotional reactions such as are seen in fear might be conditioned in this simple way. If so we have an adequate way for accounting for the enormous increase in the complexity of adult emotional life as contrasted with its simpler manifestations in infants. To start the experiment it became necessary to use some simple native or fundamental stimulus which *would* produce fear (corresponding to the electrical shock). We have already pointed out that loud sounds are the most potent of all such stimuli. We determined to take Albert and attempt to condition fear to a white rat by showing him the rat and as soon as he reached for it and touched it to strike a heavy steel bar behind him. We first showed by repeated tests that Albert feared nothing under the sun except loud sounds (and removal of support). Everything coming within twelve inches of him was reached for and manipulated. This was true of animals, persons and things. His reaction, however, to the sound of the steel bar was characteristic and what we had been led to believe is true of most if not all infants. When it was suddenly sounded there was a sudden intake of the breath and an upward fling of the arms. On the second stimulation the lips began to pucker and tremble, on the third he broke into a crying fit, turned to one side and began to crawl away as rapidly as possible with head averted.

The result of this observation showing that the loud sound would produce an expression of extreme fear gave us hope that we might be able to use this stimulus for *bringing about a conditioned emotional response* just as the electric shock combined with the sight of the colored object brought about in the end the conditioned response of the finger just referred to. Our laboratory notes showing the progress of this test are most convincing.

*Eleven months, 3 days old.* (1) White rat suddenly taken from the basket and presented to Albert. He began to reach for rat with left hand. Just as his hand touched the animal the bar was struck immediately behind his head. The infant jumped violently and fell forward, burying his face in the mattress. He did not cry, however.

(2) Just as his right hand touched the rat the bar was again struck. Again the infant jumped violently, fell forward and began to whimper.

In order not to disturb the child too seriously no further tests were given for one week.

*Eleven months, ten days old.* (1) Rat presented suddenly without sound. There was steady fixation but no tendency at first to reach for it. The rat was then placed nearer, whereupon tentative reaching movements began with the right hand. When the rat nosed the infant's left hand the hand was immediately withdrawn. He started to reach for the head of the animal with the forefinger of his left hand but withdrew it suddenly before contact. It is thus seen that the two joint stimulations given last week were not without effect. He was tested with his blocks immediately afterwards to see if they shared in the process of conditioning. He began immediately to pick them up, dropping them and pounding them, etc. In the remainder of the tests the blocks were given frequently to quiet him and to test his general emotional state. They were always removed from sight when the process of conditioning was under way.

(2) Combined stimulation with rat and sound. Started, then fell over immediately to right side. No crying.

(3) Combined stimulation. Fell to right side and rested on hands with head turned from rat. No crying.

(4) Combined stimulation. Same reaction.

(5) Rat suddenly presented *alone*. Puckered face, whimpered and withdrew body sharply to left.

(6) Combined stimulation. Fell over immediately to right side and began to whimper.

(7) Combined stimulation. Started violently and cried, but did not fall over.

(8) Rat alone. *The instant the rat was shown the baby began to cry. Almost instantly he turned sharply to the left, fell over, raised himself on all fours and began to crawl away so rapidly that he was caught with difficulty before he reached the edge of the table.*

This was as convincing a case of a completly conditioned fear response as could have been theoretically pictured. It is not unlikely had the sound been of greater intensity and the child more delicately organized that one or two combined stimulations might have been sufficient to condition the emotion. We thus see how easily such conditioned fears may grow up in the home. A child that has gone to bed for years without a light with no fears may, through the loud slamming of doors or through a sudden loud clap of thunder, become conditioned to darkness. We can easily explain how it is that a sudden flash of lightning finds you all set and tense, often times with the hands over the ears, before the clap of thunder, which is the true stimulus to such action, appears. We can thus see further how it is that the sight of a nurse that constrains the movements of the youngster or dresses it badly may cause the infant to go into a rage, or how the momentary glimpse of a maiden's bonnet may produce the emotional reactions of love in her swain.

The experimental question arose as to whether Albert would be afraid henceforth only of rats, or whether the fear would be *transfered* to other animals and possibly to other objects. To answer this question Albert was brought back into the laboratory five days later and tested. Our laboratory notes again show the results most convincingly.

*Eleven months, fifteen days old.*

(1) Tested first with blocks. He reached readily for them, playing with them as usual. This shows that there has been no general *transfer* to the room, table, blocks, etc.

(2) Rat alone. Whimpered immediately, withdrew right hand and turned head and trunk away.

(3) Blocks again offered. Played readily with them, smiling and gurgling.

(4) Rat alone. Leaned over to the left side as far away from the rat as possible, then fell over, getting up on all fours and scurrying away as rapidly as possible.

(5) Blocks again offered. Reached immediately for them, smiling and laughing as before.

The above preliminary test shows that the conditioned response to the rat had carried over completely for the five days in which no tests were given. The question as to whether or not there is a *transfer* was next taken up.

(6) *Rabbit* alone. A rabbit was suddenly placed on the mattress in front of him. The reaction was pronounced. Negative responses began at once. He leaned as far away from the animal as possible, whimpered, then burst into tears. When the rabbit was placed in contact with him he buried his face in the mattress, then got up on all fours and crawled away, crying as he went. This was a most convincing test.

(7) The blocks were next given him, after an interval. He played with them as before. It was observed by four people that he played far more energetically with them than ever before. The blocks were raised high over his head and slammed down with a great deal of force.

(8) *Dog* alone. The dog did not produce as violent a reaction as the rabbit. The moment fixation of the eyes occurred the child shrank back and as the animal came nearer he attempted to get on all fours but did not cry at first. As soon as the dog passed out of his range of vision he became quiet. The dog was then made to approach the infant's head (he was lying down at the moment). Albert straightened up immediately, fell over to the opposite side and turned his head away. He then began to cry.

(9) Blocks were again presented. He began immediately to play with them.

(10) *Fur coat* (seal). Withdrew immediately to the left side and began to fret. Coat put close to him on the left side, he turned immediately, began to cry and tried to crawl away on all fours.

(11) *Cotton wool.* The wool was presented in a paper package. At the ends the cotton was not covered by the paper. It was placed first on his feet. He kicked it away but did not touch it with his hands. When his hand was laid on the wool he immediately withdrew it but did not show the shock that the animals or fur coat produced in him. He then began to play with the paper, avoiding contact with the wool itself. He finally, under the impulse of the manipulative instinct, lost some of his negativism to the wool.

(12) Just in play W. put his head down to see if Albert would play with his hair. Albert was completely negative. The two other observers did the same thing. He began immediately to play with their hair. A Santa Claus mask was then brought and presented to Albert. He was again pronouncedly negative, although on all previous occasions he had played with it.

We see that the conditioned fear to the rat, which was experimentally set up, transferred to many other objects. The transfer was immediate and without any additional experience in connection with these other objects. In these transferred emotional reactions we thus would find a reason for the widespread change in the personality of children and possibly even of adults once even a single strongly conditioned emotional reaction has been set up to any object or situation. It accounts for the many unreasoning fears and for a good deal of the sensitiveness of individuals to objects for which no adequate ground for such behavior can be offered in the past history of that individual. The importance of such a factor in shaping the life of the child needs no further emphasis from us.

At present we are engaged upon the study of methods by means of which such directly conditioned fear responses and their transfers may be removed. The importance of establishing methods for the removal of these undesirable reactions is apparent to all. That such conditioned reactions are present in the life of every child many parents can testify. We have repeatedly had children brought to us whose emotional life had been so warped and twisted by such factors that the formation of the stable habits by means of which the race must maintain itself was seriously interfered with. Some practical procedure in the control of these factors must be found if we are to care for those children in whom accidents of nurture have built up emotional reaction systems which, unless corrected, must inevitably bring them to grief. The report on this phase of our laboratory work is not yet completed.

The sceptic will be inclined to say that such things happen in the life of a child every day but that the child immediately puts them aside and soon forgets or outgrows such happenings. We have not the full experimental data to combat this view, but we have the evidence to show that in Albert at least both the original fear of the rat and the transferred emotional reactions remained after a period of thirty days in which no experiments were made. Furthermore, the latter were still called out by the same objects which called them out in the above test. Our view is that such happenings are permanently impressed upon the growing child. They remain not only as a part of his reaction system but also they tend to modify or prevent, by limiting the number of objects that he deals with, the formation of constructive habits. In other words, they modify his vocational future. When we consider that these conditioned emotional responses are being constantly set up in the growing child, not only in the realm of fear but in the realm of love and rage, and that they bring in their train a host of transferred responses, we begin to realize the importance of the preschool age of the child; we then wonder whether our home system which more or less allows our children to "just grow," like Topsy, until public school life begins, is not a pretty dangerous procedure.

We spend an enormous sum of money each year for the education of our youth in colleges and universities. When it is realized that the college, that institution for teaching the adolescent to become a man, is at present being regarded somewhat critically, and that the universities reach only an extremely small percentage of the population—namely that portion which intends to enter some specialty—it makes us wonder whether it would not be a valuable experiment for the government or other institutions to spend a small amount of our vast educational funds for teaching the infant how to become a child. When one realizes that probably more than the income from a million dollars is spent each year in the several marine biological institutions for the study of three lower forms—the sea urchin and its progeny, the coral, and the jelly fish—it seems not unreasonable to point out that it would not be bad economy to have one or more institutions where continuous researches might be made upon human progeny. An institution where the human infant can be studied from birth to at least three years of age would be one of the most profitable research investments that could be made at the present time. It would lead to an untold wealth of new scientific conclusions and to a practical and common sense set of data upon the psychological care of the infant.

# AN INTRODUCTION TO SCIENTIFIC VAGARIES

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HOW to account for the "crank," and what to do with him, are questions that concern the general public as well as the specialist. Restrain him? He is irrepressible. Ignore him? That may be unwise for often he is half right, sometimes wholly so. He is always disturbing, and though always abnormal he is not always unworthy, and the genus is of such infinite variety that it can never grow stale. No, the crank cannot be ignored because he is always the embodiment of notions that influence others, sometimes in large numbers; he is a type. Much depends upon the point of view. Columbus was a wise and learned man to his simple minded sailors; to companions of like temper with himself he was a daring adventurer and a hero; to the incredulous savants he was a crank.

A really normal man is one whose mental, moral and physical qualities put him in what is called "normal" relation to the age and conditions of society in which he lives; he is in harmony with his environment and lives among his fellows without discord or friction.

One who continues to shape his conduct after the pattern of his predecessors, while failing to regard the advances that have been made; who will not ride in railroad cars or tolerate instrumental music in church; who declares that what was good enough for his ancestors is good enough for him, is "behind the times"; while he who is dissatisfied with prevailing views and customs, and chafes under the restraints which they impose upon him and consequently endeavors to better them, is either a crank or is "in advance of the age." If the latter is the case only the future can prove it; sometimes it does so—it may be soon, it may be centuries later.

As the "norm" would be in perfect equilibrium under the forces acting upon him from all sides, any excess or defect of qualities in an individual not thus normal, would leave him unbalanced. Just how far or in how many respects he may depart from the normal without being generally regarded as erratic, is indeterminate, but there are few persons who have not some crotchets, and those few we consider uninteresting and expect no especial achievement from them. It is only to the abnormal that we can look for any disturbance of an established order, whether for good or ill. Of these, some are a little out of line (but only a little) on many subjects; others are out of line on one

subject only, but very much out; they may be very right in general, and yet on some one topic their aberration may amount to mania. The crankiness that crops out in various fields of endeavor often exhibits surprising acumen, shrewdness, and insight, coupled with defects of reasoning no less remarkable. All this is trite, of course, to the alienist. Probably an expert in any profession encounters and could cite instances of such aberration related to his own profession, and these might all be classified. In any one branch of science they would make a formidable array, but it may be that they are all ultimately psychological. Sometimes the purely psychological aberration affects chiefly the actor himself, as in "New Thought" and such systems; and sometimes, when the performer is dishonest, it is meant to affect his victims, as in the Keely Motor and devices of that nature.

It is exhilarating to read the propaganda of strange cults among the announcements of Sunday services in the Saturday afternoon or Sunday morning newspapers of any large city. Employing various tricks of phraseology, especially alliteration, they fall readily in step with Mother Goose's rhymes or suggest the Mark Twain jingle:

Punch, brothers, punch with care;
League for the larger life.

Many of these "movements" are poorly disguised schemes for wheedling money from faddists—the old trick of "stealing the livery of the court of heaven to serve the devil in." While it is true that some projects once thought chimerical have been realized, and have thus justified their protagonists—at first villified as crack-brained, and then glorified as geniuses—the utterly fantastic character of other schemes shows an unquestionable wryness in the persons at work upon them. Education has been thought the cure for both moral and intellectual depravity, but the advocate of any of these absurdities would be classed as a "sport," a *lusus naturae,* which no amount of educating could convert into the norm. Why he so frequently and continually recurs is a mystery.

It is hard to tell which exhibits the greatest departure from the normal; the eager chaser after the will-o'-the-wisp, who is so wholly possessed by his idea that it becomes an obsession (that condition is abnormal even if he is sincere); the unscrupulous rogue who, by his plausibility, swindles his victims; or the admirers and victims themselves who, astute enough in general, are peculiarly susceptible to some particular form of deception, say scientific or religious, and who, along that line, are abnormally credulous and easily deceived—even in some instances pleased at being humbugged. The scientific mind is necessarily an open mind, and the over credulous imagine themselves especially scientific in their readiness to accept evidences of strange new truths. But they do not always properly weigh the evidence. An

array of testimony in the guise of facts, and of consequences that are unmistakable is often convincing before the evidence is known to be genuine, with no certainty that it means what they suppose, and least of all with any assured connection between the supposed cause and effect; and although "one swallow does not make a summer," a single fact is sometimes used to brace up a host of irresponsible and unfounded statements. There are well meaning people with a fair amount of intelligence, who will take keen interest in the pretensions of a mountebank if only he makes his claims startling or upsetting in character, and presses them with sufficient assurance and effrontery.

It is not the sincere worker whose efforts are based upon sound doctrine and real facts, and who works on in the face of discouragement, that we are considering, but the aberrant. Whatever may be his contention, his favorite method of establishing it is to challenge everything and everybody to refute it. If he is dishonest he wants notoriety and this will procure it for him, whether the challenge is accepted or ignored; if he is honest he is so far deluded that if his challenge is not accepted he is convinced that it is unanswerable, and if he is controverted he feels that, like Galileo and a noble army of predecessors, he is a martyr to the conservatism of the age which resents enlightenment. It is not always possible to take these disputants seriously, no matter how seriously they take themselves, neither is it always safe to dismiss their ideas as ridiculous, for many a wise man has been ridiculed and contemned by others less wise than himself; and we need not look upon a quotation from the Alice books as a sign of feeblemindedness.

In speaking of the Keely motor, an English engineer and critic makes a generalization upon the psychology of Americans that is pretty broad yet perhaps not without justification. He says:

> It is a peculiar psychological fact that among a people so energetic and hard headed as the Americans every imposture, depending for its success upon mystery, should find multitudes of believers. America is the home of Mormon, Christian Scientist, and a host of other sects, who each follow the leadership of a single person, it may be ignorant and impudent, or it may be of that much learning that maketh mad, but at least all agreeing in being mystics of the very first water. . . . American geese are always swans, and really Keely deserves a good deal of attention. (Henry Riddell, M. E., on "The Search for Perpetual Motion," in the Report and Proceedings of the Belfast Natural History and Philosophical Society, 1915-1916.)

Instead of indicating superstition, however, does not susceptibility to the unknown or the mysterious belong rather to the *unmatured* stage of a people, or such part of them as are not restrained by the conventions of those from whom they have become detached? To a people who, in some sense, are still pioneers, before they have grown stale, and while they retain a freshness of imagination to which they are not unwilling to give a loose rein; a condition which made Americans exuberant and bombastic, and gained for them a reputation that will require

a long time to live down. That would account for the free play of fantastic ideas among Australians as well as among Americans—ideas which usually find fertile soil in newly settled and rapidly developing countries.

Libraries serve as reservoirs into which erratic papers and pamphlets flow in streams. A typical collection of sixteen quasi-scientific pamphlets, bound together under the general title "Paradoxes," in the New York Public Library, illustrates the lengths to which such aberration may go. Several of the papers are notable, and one or two are notorious. Merely to scan the titles is enough to make one dizzy; they are not all old, some might be called recent. One or two will serve for illustration. No. 4 is:

> Six General Laws of Nature—(A New Idealism)—A COMPENDIUM—of—A Large Work Divinity and The Cosmos—Containing—The Positive Cause of Force and Matter, An Explanation On All The Physical Phenomena in the Actuality of The Universe, and an Attack on the Modern Scientists and Philosophers.—Solomon J. Silberstein—New York—1894.

To judge from the weightiness of this "Compendium" the "Large Work" would be crushing. Mr. Silberstein also has another on "The Existence of the Universe—The Causation of Its Origin, etc." which sets one wondering.

The papers are most varied and fantastic; one is a rhapsody of Man, God, Geography, Electricity, Sun, Moon, and Tides, and contains the announcement of "an extensive work entitled 'A New Bible' to explain in detail the scientific principles in the above topics"! In another the Rev. John Jasper is revived and the earth is proved to be a "stationary plane circle"; the Newtonian theory of gravitation is severely manhandled by several of the writers; and cosmic theories are proposed by some and overthrown by others; one especially affects odd words, and another article is made up wholly of epigrams and ejaculations of two or three words each.

An attendant in an asylum for the insane, speaking of the idosyncrasies of the patients, said that the form their hallucination would take "depended altogether on *the temperature of their minds.*" (He was himself apparently somewhat mixed on temper, temperature, and temperament.) Some of the writers of these papers rival the projector in the Grand Academy of Lagado, spending his labors on a project to extract sunbeams from cucumbers.

During the Middle Ages superstition was rife in science, and vagaries abounded; in the eighteenth century a great clarifying was in progress, and by the beginning of the nineteenth extreme ideas of science were thought to have reached their acme of extravagance in seven different forms corresponding, perhaps, to the seven wonders of the world, and called the "Seven Follies of Science." This designation is itself a survival of a tendency as old as counting, to recognize some

peculiar potency in a number like three or seven (particularly seven) as magical or sacred; and this tendency may be only another instance of the very peculiarities we are setting out to consider.

The late John Phin, in "The Seven Follies of Science," distinguishes properly between fraud and honest effort to discover and utilize the secrets of nature. In so discriminating he, with others, rejects astrology and magic because they are frauds, and gives as the generally accepted list of "Follies":

1. The quadrature of the circle; or as it is called familiarly, squaring the circle.
2. The duplication of the cube.
3. The trisection of an angle.
4. Perpetual motion.
5. The transmutation of the metals.
6. The fixation of mercury.
7. The elixir of life.

I. D'Israeli, in "Curiosities of Literature," enumerates the "Six Follies of Science," omitting Nos. 3, 5, 6, and 7 of the above list, and including:

4. The Philosophical (or Philosopher's) Stone.
5. Magic.
6. Judicial Astrology.

Nos. 1, 2, and 3 above are purely mathematical and do not belong in a list that is limited to the physical sciences. The others are things to be achieved or produced by experimental processes or search and in that class come also,

8. The Universal Solvent; and 9, The Fountain of Youth. This, indeed, is only a variant of No. 7, but it has been hardly less alluring than the others.

In their relation to the existing state of knowledge these have all stood, in their day, as rational topics of inquiry, and therefore as legitimate questions to which a conclusive answer might be expected. For this reason they ought not to be called follies, for even if they may now be regarded as such it was not always so, and with as good reason we might regard as folly almost any novelty in the development of science. So we call them fallacies or foibles when we are not dealing with outright fraud; in that case we have "perversion" of science. In most instances the great difficulty has been to determine the line between honesty and deceit. Even frauds would not be excluded from foibles in all cases, for it is impossible to know how far astrologers and soothsayers came to believe in their own schemes of forecasting and divining. Charlatans and fakers have possibly been self deceived, especially in religion. Certainly some weather predicters have believed in their scheme of forecasting, even if they did not believe in themselves.

It will be seen that in the above lists, some of the subjects that have been dismissed as chimerical have been capable of reaching a phase such as science now approves, and various chimeras, once laughed out of court, have returned to make good their claim to acceptance and to serve us. As notable examples that have been realized we have aviation, self propelled vehicles, and apparently the transmutation of metals. Geographical vagaries have sometimes been of wide scope and long sustained interest as, for example, the myth of Atlantis, the Northwest Passage, the Fountain of Youth, El Dorado, Symmes' Theory of Concentric Spheres, and still others. In 1492 the spherical form of the earth was a foible of Columbus.

An announcement of any startling achievement for which the public has not been prepared by gradual approach, is almost certain to encounter incredulity. Today the X-rays are commonplace, yet not only laymen but professional physicists were skeptical of them when the first announcements of them were received in this country. A final solution of the great problems of physics and chemistry, such as gravity, heat, electricity, radiation, etc., involves the ultimate nature of matter—itself the greatest problem of them all—and while the search for its solution continues vagaries will certainly come and perhaps go. No innovation that appears to be subversive of established ideas can acquire a standing without overcoming opposition in various forms, and one of the earliest and most effective forms that it has to encounter is ridicule or satire. But it has happened more than once that the chief fault with the innovation was that it was premature; and while in such case it needs great vitality to survive the ridicule with which it is met, if it is really true it is likely to reappear after an eclipse. Does it necessarily follow, however, that if it reappears it is really true? That has occurred with some systems of divining that have been scouted by orthodox scientists. Nevertheless, doctrines that have stood as sound science in their day, reached maturity and flourished, which died and were buried, may yet be awaiting resurrection. Some of them, if they were now being promulgated for the first time, would be either ignored or laughed at in the light of modern knowledge which would show their fallacy. Again, apparently defunct notions have been resuscitated and revamped and brought into harmony with present day knowledge and practice, have been shorn of excrescences that deformed them and stripped of dress that disfigured them; and in consequence, doctrines that had been rather fantastic have received a real scientific character, and truths that had fallen into disrepute may have been rescued. This seems to be the case with physiognomy. Some vagaries are veritable Banquo's ghosts and will not down. Insuppressible and irrepressible, with these revival takes the place of survival, and they return again and again to plague one, or else to establish finally an indisputable right to live. Reversing the usual order, the follies of one generation

have sometimes become the wisdom of the next. But it is not easy to escape contamination with bad associates, and upon any recurrence of old vagaries, even if they come bearing the promise of reform, they are apt to be put in the same class with new ones. Of these we have a superabundance in the shape of New Thought, Faith Healing, The Power of Will, etc., crowding the advertising columns of newspapers and magazines. What with short cuts to success, and marvelous methods of increasing one's power in all lines of endeavor, along with the ability to read character at sight, it would seem as if there were no excuse for anybody with moderate ability to stop short of the topmost rung in the ladder of Fortune or indeed to rest with only moderate ability. The situation is hit off well in an editorial of a current periodical:

> Life as it is lived by the rest of us must seem like loafing to those who have had their memories trained so that they can get the telephone book by heart in an evening, who have studied the science of physiognomy until they can place a passing stranger at a glance, and who have mastered the secrets of will power to such an extent that it is folly to dispute their purposes. Existence must appear a strangely pallid affair to you when there is no occasion to which you are not equal and when you have reduced the problems of every day to a series of logarithms, and locked them fast in an unshakable memory. (The Globe and Commercial Advertiser, New York, Nov. 12. 1919.)

While some of the old "Follies" persist, the progress of science has brought new ones to the fore and has focused attention upon wonders of a kind that did not—could not—enter the minds of the ancients. Whether the elixir of life, the fountain of youth, or the universal solvent has passed out of question or not, perpetual motion still engages the attention of inventors. The fact is, the thing that has become known and established has ceased to inspire the researcher. He is ready to pass that on to the utilizer, while his imagination revels in chimeras. A world consisting entirely of known facts would be as fatal to imagination as an arid world to vegetation.

# THE GOVERNMENT LABORATORY AND INDUSTRIAL RESEARCH[1]

By GEORGE K. BURGESS, Sc. D.

CHIEF OF THE DIVISION OF METALLURGY, BUREAU OF STANDARDS

YOUR Chairman has asked for a contribution to this symposium on Research setting forth the relations of the Government Laboratory to Industrial Research. In the short time available, you will not expect more than the briefest outline of the attitude of one or more typical laboratories toward the encouragement and development of research in industry, the most concise possible of statements describing how a government laboratory functions in relation to industrial research problems, and a bare mention of but a few of them.

There has been a great deal written recently concerning the various aspects of industrial research and especially the rôle that is being played, or should be played, by each of the various types of organization, such as the Engineering Society, the university, the independent research organization, the Government, and industry itself; and the discussion often has centered about the cooperative aspects of research as between two or more of these parties.

It is generally conceded by representatives of industry that industrial research has for its immediate object the increase of profits, and consequently the brunt of the cost of maintenance should be borne by industry, which should also itself carry out at least the greater part of the research work required. There is a very great divergence of appreciation of the need and value of research in the various industries, and the practices and methods also vary greatly.

It is generally conceded that the rôle of the university is to train men and increase our store of knowledge; many think useful cooperative arrangements in research may be made between the university and industry, and many illustrations are available.

It is not the purpose of this paper to go into a philosophical or academic discussion of what part the government laboratory should play on the stage of industrial research but rather, accepting the facts and tendencies as they are, to state briefly, if inadequately, what two of the government bureaus are trying to do to encourage and help industry through research in science, engineering and technology.

[1] American Society for Steel Treating, September 23, 1921, Annual Convention at Indianapolis.

It has been well said: "All research is in the public interest, and that from the public viewpoint the sole difference between abstract and applied science is one of degree and not of fact; that the important point is increased research activity irrespective of where or by what means it is carried on."

If, therefore, the public has an interest in and derives benefit from industrial, scientific research, it is both fitting and fair for the public, through the agency of the Government Laboratories, to both participate in and help support such research.

It also follows that there should be established and maintained the closest relations between the representatives of industry, on the one hand, and of the government laboratories, on the other. This intimate contact should evidently not be limited to scientific and technical staffs of the industrial and government laboratories, but should embrace also the directors of policy in industry and government.

There is another and most important characteristic of the government laboratory in its relation to this question of industrial research, one that has been often mentioned, namely, the desirability in many cases of having the work done, in whole or in part, by an impartial body representing the public and on whose results will be impressed the stamp of authority; as in cases in which if one or the other party, as producer and consumer, either alone or together, published the results, they would not, however well executed, carry the desired weight.

Again, one should not lose sight of the fact that our government is the largest business organization in the country, the most important buyer and also maintains several types of industrial or manufacturing plant of a highly technical nature. So the government itself, in the conduct of its business, is a party vitally interested in the progress of industrial research, economies in buying, and standardization of products. The results obtained in its laboratories on its own problems are freely given to industry. The rôle of the Bureau of Standards has been preeminent in research for the government and many of its activities in the field of industrial research have been started for the purpose of meeting government needs for information relating to improvements in manufacturing processes, standardization and the formulation of specifications. As illustrations, may be cited the investigations relating to cement, concrete, paper, leather, rubber and textiles, for which small manufacturing plants have been installed.

It is often maintained there are three essential steps in many branches of industrial research, particularly as related to new processes; first, the laboratory investigation; second, the development on a small manufacturing scale; and last, full scale production, all of which require experimentation. The government bureau may be and often is associated with all three of these stages.

What now do we find to be the relation of the government laboratory to the industries of the country?

We may perhaps best approach the subject by asking of what aid can the government laboratory be to the American Society for Steel Treating, to its members individually and to the industries it represents?

There are two government bureaus the work of which is most nearly related to the scope of interests covered by this society, namely, the Bureau of Mines and of Standards. Each of these bureaus is vitally concerned with promoting the welfare of the nation in matters relating to their respective fields. They may be considered as great technical service bureaus to which the engineering, scientific and technical interests of the country may apply for help in solving many of the underlying problems of general interest in mining, technology, engineering, physical and chemical science, and in standardization, on all of which progress in industry is based.

From the viewpoint of cooperation with industry, how do these two institutions function with respect to industrial research, which we may define as research with an avowed utilitarian motive?

Let us consider first the Bureau of Mines. In the annual report of the director for the year ending June 30, 1920, appears this statement:

> During the past few years the bureau has been building up investigative work with outside cooperating agencies in a manner unique among Federal bureaus. The detailed agreements entered into differ among themselves, but the fundamentals are these:
>
> 1. Some state, or university, private or semi-private organization has problems in mining or metallurgy the solution of which would benefit itself and the public.
>
> 2. These outside agencies agree to pay part or all of the cost, both in personnel and materials, of the investigation, which is to be carried on under the direction of, and according to, the methods of the Bureau of Mines.
>
> 3. The Bureau of Mines retains the right to make public and print the results of all such investigations.
>
> So successful has this method of solving problems been that at present the bureau has cooperative agreements with State agencies in 11 states, with 12 different universities, and with 19 private and semi-private agencies. And the total amount of money being spent by the outside agencies on these cooperative agreements, mostly under the direction of the bureau, has amounted to approximately half a million dollars during the present fiscal year. In addition, a number of representative concerns in leading mining and metallurgical industries have appropriated money to be spent under the direction of the Bureau of Mines in production of educational motion pictures illustrating various mining and metallurgical industries. The bureau has found that these films are in great demand by the public, and that they have materially assisted the wide dissemination of information concerning the industries.

As in the case of agriculture, the mining industry is scattered over a wide geographical area and the problems to be solved are often local;

therefore it was but natural for the Bureau of Mines to follow the practice of the Department of Agriculture in establishing experiment stations at suitably located points for the study of problems relating to the mining industry.

The Bureau of Mines is also charged with the government work on fuels—a subject of no little interest to the membership of this society—which include, of course, coal and petroleum products of widely diversified types and situated in many areas. In its study of fuel problems, the Bureau of Mines has carried on both the field and station type of investigation but has also been able to concentrate in one or more central laboratories much of its fundamental research work.

In problems relating to process metallurgy, such as the recovering of the various metals from their ores, much the same procedure has, of necessity, been followed as for the mining operations, namely work at outlying stations. In both mining and metallurgical investigations it is the custom to cooperate on an intimate and intensive scale with existing industrial plants, to the very great benefit in the increase of our knowledge and improvement of the processes concerned, to say nothing of the evident economies of such methods of cooperative investigation. With the experience gained by this Bureau in successfully overcoming the difficulties in one region available for new problems as they may arise elsewhere, there is evidently also elimination of much wasted effort in trying out a new or modified metallurgical process.

In its investigations relating to mineral technology and elimination of waste in metallurgical operations, this Bureau is doing much of direct interest to this society, such as smoke and fume abatement, health conditions in shops, furnace design and operation, metallurgical refractories, and the making of alloy steels, a long list, the consideration of which here would take us far afield.

Turning now to the Bureau of Standards, we may note certain differences in methods and procedure as compared with the Bureau of Mines. We have seen how the latter bureau maintains a large number of widely scattered units or stations. In contrast to this decentralized practice, the Bureau of Standards has practically all its work concentrated in a group of laboratories at Washington although it has maintained an important station at Pittsburgh mainly for engineering work on structural materials which station, however, is being moved to Washington; there are also a few small detached stations for cement and chemical testing.

Again, the Bureau of Standards has followed less generally than the Bureau of Mines the practice of entering into formal cooperative agreements with States, and other public or private bodies. We have usually adopted the less formal, but nevertheless effective, practice, in our relations with industry, of orienting and organizing our work through the instrumentality of committees representing industry.

It has been said committees do no work and therefore are unnecessary, but a moment's consideration will show that in many ways a well organized committee is most valuable, if not indispensable, in laying down principles and suggesting policies, resulting from the united experience of all its members. The Bureau of Standards finds in many lines of its work relating to industrial research that the committee method of outlining the problem is the only feasible one. There is established a mutual confidence among all interested parties so essential in attaining the maximum output with minimum risk of misdirected effort.

As a text defining the Bureau's relation to industry, let us quote again from Mr. A. W. Berresford in his presidential address before the American Institute of Electrical Engineers:

> I conceive it to be the prime duty of the industry, first to agree on what shall be the scope of the Bureau; second, to educate the Bureau in its conditions; and third, by demanding that its interests be heeded, to secure adequate support of the Bureau.

At the outset, it may be laid down as axiomatic that the director of the bureau has never considered undertaking any problem in research relating to industry without first consulting representatives of that industry, either as a group through some organized body speaking for the industry or by consulting with men of authority in the industry. Many are the illustrations of this practice; for example, there has been for years a committee appointed by various bodies interested in non-ferrous metals, known as the "Committee Advisory to the Bureau of Standards on Non-Ferrous Metals," or for short, the non-ferrous committee, which meets at the bureau twice a year. All the work on this subject is gone over before and during its execution, so that the non-ferrous metal investigations of the bureau have not only the endorsement of the industry but the industry itself formulates the program. If progress in this domain has been less rapid and extensive than we should like, may we then say that, although the first two of Mr. Berresford's conditions have been met, the third is lacking?

The work on railroad materials has, less formally, been largely mapped out as a result of meetings held at the bureau of representative railroad groups. Sometimes a specific problem that appeals to the bureau may be presented by some railroad together with a manufacturer; such was our work on rails from different ingot types, and the investigation now being conducted on Titanium treated rails; or again a manufacturer's association as that of Chilled Iron Car Wheels may ask the bureau to cooperate in carrying out an investigation—just completed—on thermal stresses in chilled iron car wheels as related to design and braking; or it may be an unorganized group, as that of the steel wheel manufacturers, asking for and getting a similar investigation. Nor should there be forgotten the bureau's activities in the realm

of engineering materials in its relation to the numerous committees of the American Society for Testing Materials, which committees are fairly representative of both the consuming and producing elements of their respective industries and represent as well the engineering public. I suppose the list of direct or implied requests for work by this engineering body alone would reach the size of a substantial volume.

Another problem and another type of organization. Whether he realizes it or not, every one in this country is vitally concerned in the limitations set for sulphur and phosphorus content in various grades of steel. If these limits are fixed too rigidly the cost of living rises, if too loosely, the life hazard of all of us is increased. This problem was brought formally to the bureau's attention by two bodies, one representing the government, the other the engineering fraternity; or by the Railroad Administration and the Society for Testing Materials. A joint committee was formed representing the government departments, the specification making bodies, and the manufacturers. The testing and research is carried out in the government laboratories at Watertown, Annapolis and Washington, and the steel is specially produced for the investigation by the manufacturers under the oversight of the committee. A unique feature of the conduct of this investigation is that there is not a two sided table with manufacturers on one side and the users on the other—but it is a round table affair with each man responsible for endorsing each stage of the program so that no member can later say, why did you not do this or that?

The bureau's investigations on electrolysis as related to public service companies and cities are being organized on a somewhat different but nevertheless highly satisfactory basis, in which all interested parties are represented and the program put up to the bureau by them.

Hardly a day passes that there is not one, sometimes several, formal or informal conferences at the bureau by groups representative of industry who are interested in having the bureau undertake problems of research fundamental to their industry, and at those conferences the work to be done is usually mapped out, at least on general lines and often in great detail.

At the present time much attention is being given to problems relating to the elimination of industrial wastes. The possibilites of progress in this field are of unlimited extent. In a sense, of course, all industrial research from which beneficial results are obtained lead inevitably to the equivalent of elimination of waste by conservation and better utilization of materials, improved quality of products, recovery of by-products, increased efficiency of performance, or discovery of new processes and products. There are, however, many instances in industry in which the waste, as such, is evident and manifestly preventable, and it is to problems dealing with these classes of waste to which

I refer. As examples we may mention the enormous losses caused by corrosion, inefficient furnace operations, excessive use of manganese, and other preventable losses of material and energy in steel manufacturing operations.

Another field of industrial research, and one that will grow in importance, relates to our foreign trade, particularly the specification and testing of materials for export. The establishment and maintenance of standards in this wider competitive field will require much more experimental research than might be thought necessary by one who gives the matter but hasty attention. In fact in the realm of standardization and specifications, as those of you know who may be familiar with some phases of this subject, you never get far in writing a specification before you enter the unknown, and the way can be cleared only by further experimental investigation.

We might cite many other types of problem related to industrial research on which the Bureau of Standards is now working or is qualified to assist in solving in collaboration with industry, but I trust what has preceded has given you a better idea than you had before of the relation of the Bureau to industry and the readiness at all times on its part to participate with industry in the solution of those problems of general interest coming within its scope. The same is, of course, equally true of the Bureau of Mines.

Before closing, I would like to mention one other type of activity at the Bureau—still in an undeveloped state—which gives promise of being of considerable value to industry. I refer to the practice started about two years ago of an industry sending men to work at the bureau on problems that industry is interested in having solved and for which the equipment and atmosphere of the bureau may be particularly suited. This practice was instituted by the bureau largely in self-defense at a time when manufacturers were drawing men from it in alarming numbers and it was also coincident with the reduction of the bureau's funds. We call these men Research Associates or Assistants, and at the present time there are twenty, six of whom are working on metallurgical problems, and the others on problems relating to hollow tile, terra cotta, visibility, lime, gypsum, plasticity of fats, cement, and the constants of ammonia. There are great possibilities in the extension of this system under which men are trained as well as problems solved, and the benefits to industry are self-evident.

Much might be said of the educational advantages of the government laboratory in training men for research positions in industry. The Bureaus of Mines and Standards often have been severely crippled by losing men to industry. It is not in general to the advantage of industry to so cripple an organization working for the benefit of industry.

A last word—and only a word—as to the cost of research, indus-

trial or any other. It is trite to say it is expensive, so is life insurance; but it is far more costly not to support research adequately, just as it is not to make provision for future contingencies. It has been said that such government laboratories as the Bureaus of Standards and Mines are luxuries we can easily dispense with; yes, just as the farmer's seed and fertilizer can be dispensed with to his ruin. What does it cost per capita for the Bureau of Standards or the Bureau of Mines? Almost exactly a cent apiece for each inhabitant of this country, which if I were not a member of the staff, I would characterize as dirt cheap, the price of the tax on one ten cent "movie" ticket.

The American Society for Steel Treating is concerned with many problems, some of them of great intricacy, involving not only the perfection of practice in the subject of heat treating but dependent also upon the new facts to be discovered relating to the properties of the various types of steel and the characteristics of many auxiliaries such as fuels, refractories, pyrometers, quenching media, furnace control and design; problems relating to geometry and mass of heating and cooling objects, and many others.

We, at the Standards Bureau, would be glad to see formed within this society, a committee advisory to the Bureau on Heat Treatment of Steel, which would enable us to keep in touch with each other so that the bureau's efforts in this field of investigation would be constantly in harmony with the most progressive minds in the country interested in furthering progress in this subject.

Finally, I want to make a special plea for scientific research in industry at this time. We have been witnessing, during this period of depression, the cutting down and even entire wiping out of many research departments. How many times have we all heard the argument: in times of prosperity we have not the time and do not need research, and in hard times we cannot afford it? In my opinion, the wise Board of Directors is the one which stimulates research in hard times even if it has to borrow money to do so. Competition will be keener than ever as prosperity returns and the company which has in the meantime sharpened its tools by increasing its research facilities will score in the long run. There is no greater economic waste than wrecking a going research group.

# AMERICA'S FIRST AGRICULTURAL SCHOOL

By Dr. NEIL E. STEVENS

U. S. DEPARTMENT OF AGRICULTURE

THE establishment, a century ago, of "an institution destined to prepare youth by a scientific education to become skillful farmers and mechanics" is in itself notable. As the Gardiner Lyceum was not only our first agricultural school, but the first institution to receive a state appropriation for agricultural instruction, its foundation may almost be said to mark an epoch. The importance of agricultural schools and colleges in our educational system renders of present interest a brief sketch of this pioneer institution, which emphasized the practical value of science, and introduced an elective system, student self government and winter short courses.

The idea of such a school originated with Robert Hallowell Gardiner, who was a member of its board of trustees and its chief benefactor. Of this remarkable man, pioneer in many lines and promoter of everything that seemed for the good of the community which now bears his name, little need be said. Sympathetic biographical sketches are avilable (5) and his work is mentioned in several histories of Gardiner, Maine (7). His part in the origin of the Lyceum is, however, of direct interest and is told in the manuscript autobiographical notes which he prepared some years before his death and which are now in the possession of his descendants, who have courteously made them available to the writer.

In beginning his account of the foundation of the Lyceum, Gardiner states that he had frequently been impressed by the fact that skilled workmen, such as surveyors and millwrights were

> wholly ignorant of the principles upon which their arts depend, so that when anything occurred out of the common routine, I found them utterly at a loss how to proceed. Our farmers were still less intelligent.
>
> After reflecting much upon this subject, I became impressed with the belief that an institution might be established which would put the acquisition of so much science as was requisite to make skillful farmers, millwrights, and other mechanics, within the reach of all who wished to follow these branches of business. I communicated these views to a number of gentlemen of practical intelligence who highly approved them, as was shown by their subsequently sending their sons to the Lyceum when it was established. Wishing the co-operation of my fellow citizens, I called a meeting and proposed the subject, which produced a hearty response.
>
> I proposed to give as an endowment 312 acres of land fronting on Kennebec River, and valued at $3,744.00 to which I subsequently added 122 acres adjoining, making a total of 434 acres valued at $5,208.00. They proposed to erect the building to which I only contributed $100.00.

The building referred to was a substantial two-story stone structure, and its erection by subscription is evidence of real interest in technical education in that community. In the development of such a sentiment the work of Dr. Benjamin Vaughn (3) in making available through publication in this country European work on agriculture, notably the now little known "Rural Socrates" (1800) and some extracts from Buffon's works, in urging the importance of experimental study of agricultural problems, and in the establishment of agricultural societies, must have played a large part.

The grounds and building for the new school being thus assured the state legislature was petitioned for an act of incorporation and for assistance. A portion of this petition is here quoted for the statement it gives of the purposes of the Gardiner Lyceum.

> The petition of the subscribers represents that a donation has been offered of land lying on Kennebeck River, estimated at $4,000.00 for the purpose of establishing . . . a school for teaching mathematics, mechanics, navigation and those branches of natural philosophy and chemistry which are calculated to make scientific farmers and skillful mechanics.
>
> And whereas it is an object of very great importance to any state . . . that its citizens should possess an education adapted to make them skillful and able to improve the advantages which nature had so lavishly bestowed upon them, and whereas the State of Maine . . . has hitherto omitted to make provisions for giving instruction to her seamen, her mechanics, and her farmers, upon whom the wealth and prosperity of the State mainly depend . . .
>
> They would therefore pray your honorable bodies to incorporate a school for the above purposes, with a body of seven Trustees with the usual powers and privileges, to be called the "Gardiner Lyceum" and to grant such aid as will enable the Trustees to bring the school into immediate usefulness. Signed by R. H. Gardiner and 53 others.

In response to this petition the Maine legislature passed what is apparently the first recognition, by an American legislative body, of a distinctively agricultural school.

> Private acts of the State of Maine, Chapter CVIII.
>
> AN ACT to incorporate the Trustees of the Gardiner Lyceum.
>
> Sec. 1. *Be it enacted by the Senate and House of Representatives, in Legislature* assembled. That an institution, designed to prepare youth by a scientific education to become skillful farmers and mechanics, be established in the town of Gardiner, to be called the Gardiner Lyceum; and that Robert Hallowell Gardiner, Peter Grant, Sanford Kingsberry, Frederick Allen, John Stone, and Edward Swan, Esquires, be and they are hereby incorporated into a body politic, by the name of the trustees of the Gardiner Lyceum; . . .
>
> (This act passed January 30, 1822).

The Gardiner autobiography states that the name "had been chosen to distinguish the institution as distinct from a high school or college" and further that "Mr. Allen almost immediately resigned and Mr. Evans, who was very efficient in carrying out the objects of the institution was elected in his place".

The next step was the publication, in 1822, of an "Address to the Public" from the trustees of the Gardiner Lyceum. This address, which was prepared by Mr. Gardiner and signed by him in the name of the trustees, stresses the importance of a knowledge of science in practical affairs, and outlines the objects of the institution, as indicated by the following quotations:

> The practical utility of science cannot be doubted, in an age where its investigations have produced such astonishing improvements as in the present. There is scarcely an art, which has not directly or indirectly received from it important services, for science must necessarily be the foundation of every art.
>
> With a view to furnish to farmers and mechanics the education here represented as so useful, the Gardiner Lyceum has been established; and the course of study will be arranged with particular reference to the wants of those classes, for whose particular benefit it was designed. As soon as a suitable apparatus can be provided, lectures will be given upon the sciences there taught; and the application of those sciences to the arts will be illustrated as fully as the nature of lectures will admit.

Gardiner states in his autobiography that, "Copies of the address were sent among others to the two ex-presidents, Adams and Jefferson, from both of whom I received civil answers approving the plan". Thus, even in small ways, did these two great Americans promote the cause of education.

The address referred to announces the opening of the school early in January, 1823, and the appointment of Mr. Benjamin Hale, a tutor in Bowdoin College, as principal and lecturer in natural philosophy. Of him the Gardiner autobiography says with apparent fairness:

> Mr. Hale was admirably adapted to the situation. He was a man of great insight into character, and with a strong disposition to break through established routine when change offered improvement, and therefore entered warmly into a plan which though novel, promised essential benefit to an important class in the community. He had the power of gaining the confidence and commanding the respect of young persons intrusted to his charge, for while he was earnest to give them high motives of action, he thought it better not to notice and punish trifling misdemeanors arising rather from boyishness than from bad disposition.

Mr. Hale's inaugural address, which was published by the trustees, follows Mr. Gardiner's publication in emphasizing the practical importance of science and states the object of the Lyceum in these words:

> In exhibiting, as we have endeavored briefly to do, the connexion of science with the useful arts, and showing the importance of the former as the foundation of the latter, we have given you in part the views, which led to establishment of the Gardiner Lyceum. It is the object of this institution to give instruction in those branches which are most intimately connected with the arts, and to teach them as the foundation of the arts. In this respect we believe its design to be original.
>
> But it is plain that to practical men science must be taught in a practical manner. We are taught this by the frequent failures of men who are not deficient in the general principles of science, but who are unacquainted with the particular science of the arts.

Under Hale's enthusiastic leadership the institution throve. In January, 1823, an appropriation of one thousand dollars and the tax on the Gardiner bank amounting to another thousand was secured from the state legislature. The catalogue published in November, 1823, shows that there were twenty students, the next fall there were fifty-three and in February, 1828, a committee of the Maine legislature reported that,

> Since the Institution commenced its operations, the number of students who have been instructed there, for longer or shorter periods of time, is one hundred and ninety-one. Many of these have completed the whole term of three years . . . Several have remained for shorter periods having in view the attainment of but one particular science, such as surveying, mechanics, navigation, chemistry, . . .

The catalogue for 1823 announces (p. 9) an elective system which must have been as much of an innovation as the school itself.

> It will be seen at once, from the remarks above made, that the course which will be pursued cannot be minutely detailed as it must often be subject to variations from the necessities of students, arising from the nature of the object they have in view and the pursuit for which they wish to be qualified. These objects and destined pursuits of the students will ever be attended to, and no one will be obliged to study that, which will not be of material service to him . . . Where there are several who are under the necessity of leaving the common course, and their studies take the same direction, they will form a class, and if a suitable text book can be found, recitations will be had as usual. But in most cases, particular studies, such as the application of chemistry to the individual Arts, will be pursued by one or two only, and suitable books for recitation can rarely be had. Such students must pursue such a course of reading as will be pointed out to them, and will be assisted by frequent Examinations and Explanations, and will have when necessary the liberty of privately experimenting.

The announcements in the catalogue for 1824 were even more startling and include the inauguration of winter short courses for those unable to attend the full session, with instruction in surveying, navigation, architecture, and chemistry; and the development of a plan of student self government not unlike that in use in some colleges to-day. The catalogue for 1824 concludes with this optimistic remark:

> We hope that the time is not far distant, when it shall be as common for farmers and artists, to prepare themselves for their business by a suitable and thorough education as for lawyers and physicians.

In August, 1827, Mr. Hale resigned to become professor of chemistry at Dartmouth. Of this the Gardiner autobiography says:

> His loss was irreparable. He had identified himself with the institution, and associated its success with his own reputation.

In January, 1828, there appeared the first number of the *New England Farmer's and Mechanic's Journal*, this monthly which was published in Gardiner, continued for ten numbers, and contained original and quoted articles arranged under three headings, Mechanics,

Agriculture and Miscellaneous. Under the first head were included descriptions of such machines as the "Bliss moveable hay press" and "Lane's patent Corn-Sheller"; under the second were discussed "Economy in fodder" and "Preservation of Potatoes" and similar subjects; while the third division included such timely matter as "Method of making Transparent Soap" and "Blacking-Balls for shoes." The cover of the journal bears the inscription,

Conducted by E. Holmes, M. D., Professor of Chemistry, Natural History and Agriculture in Gardiner Lyceum.

Ezekiel Holmes, a graduate of Brown in 1821, and of Bowdoin Medical School in 1824, was appointed to the faculty of the Gardiner Lyceum in the fall of 1824. Whatever his influence in that school, and the Gardiner autobiography indicates that it was not great, his connection with it was apparently effective in directing his attention from medicine to agriculture to the great benefit of agriculture in the State of Maine. He was for over thirty years editor of the *Maine Farmer*, the first secretary of the state board of agriculture, and of the state agricultural society and the

last public act of his life was that of securing from the legislature in February, 1865—but a week before his death—an act which established the State College of Agriculture and Mechanic Arts as a separate and independent institution. (4:44-46).

After 1831 state aid for the lyceum was withdrawn, and at this time Mr. Gardiner himself recommended that the school be closed, "but the feeling of the citizens was so strong for its continuance" that an attempt was made to carry on the work. The nature of the institution, however, became gradually changed until the studies were practically those of the other academies throughout the state. Whereas in 1824 the course of study included no languages except English, and featured chemistry, natural philosophy, agricultural chemistry, mathematics and navigation; fifteeen years later (catalogue of 1839) the course of study included Greek, Latin, French and Spanish, with science occupying an inconspicuous place. In 1839 a "Female Department" was opened in the lyceum. In 1848 it was reorganized as an academy, and in 1857 the building, which was later (1869) destroyed by fire, was sold to the city of Gardiner and occupied as a high school. (7).

The question naturally arises why an institution so broadly planned and so successfully started should have decayed so quickly. For its continuation as a popular institution state aid was necessary and this could not be secured after 1831 for reasons set forth by Gardiner in his autobiography.

The plan of the school required considerable funds for its support, and from the general approbation with which the plan was received by the public, it was supposed that these funds would be readily granted by the Legis-

lature. It had however been but a short time in operation before jealousies were excited, and opposition grew up in various quarters. The Academies found their scholars attracted to the superior education at the Lyceum, and the Colleges believed that they would lose scholars who could dispense with the classics and be satisfied with a more practical knowledge, attained with a less amount of time and money.

Then came into operation the religious prejudice. All the higher institutions of learning were under the patronage of some particular denomination. They therefore combined against an institution which claimed no sectarian support . . . . . [and] it was evident that no further aid could be expected from the State.

The work begun by the Gardiner Lyceum has not been neglected, however. Robert Hallowell Gardiner concludes his autobiographical record of the lyceum with a reference to the establishment of the Lawrence Scientific School and to the fact that many

colleges have modified their laws . . . a higher practical education is therefore now afforded to those who desire it than could be attained at the Lyceum, which was only designed to give needful instruction to the laboring mechanic without raising him out of his position.

The very years those words were written (probably 1859-1861) there was being pressed in Congress an act which was to establish in every state institutions for the very purpose and along much the same lines as the Gardiner Lyceum. Indeed, so wholly in sympathy with the aims of the lyceum was the author of that act, Justin S. Morrill, that it is difficult to avoid the belief that he knew of the Gardiner institution. Morrill was a young clerk in Portland, then the capital of Maine, from 1828 to 1831, years in which its claims were being actively pressed before the legislature. May not the future legislator then have followed with interest the discussions upon the Gardiner Lyceum?

## STATE AID

One thousand dollars as the annual expenditure of a state for agricultural education seems small, but a century ago, forty years before the passage of the Morrill Act by Congress, such a step was evidence of unusual progressiveness and interest. This appropriation, first made in 1823, and renewed in 1825 for three years, and again in 1828 for three years, was apparently the first allotment of public funds for agricultural education in the United States. When it is remembered that this enactment was made by the legislature of a new and sparsely settled state, for an institution wholly new in design, the wonder is not that the appropriation was so small and continued for only seven years, but that it was made at all.

That so advanced a position was taken by Maine legislatures at this early date is due to several influences. The state was strongly committed to a policy of public support of education by the recently adopted constitution. In fact the portion of that constitution which deals with education and authorizes state support of academies and col-

leges (Article VIII) had been prepared only a few years before by Thomas Jefferson, founder and even then the acknowledged leader of the party to which a large majority of the legislature belonged. Moreover, Maine was fortunate in her early years in having a succession of able and progressive governors who were interested in education.

The first governor, William King, was, as a member of the constitutional convention, active in having Article VIII included in the constitution, and later (2) vouched for the fact that it was in substance prepared by ex-president Jefferson. The portion of the message of Governor Albion K. Parris, which deals with the Gardiner Lyceum, deserves partial quotation.

> An institution has recently been established in Gardiner, upon a plan original in its design, but promising much solid public utility. The encouragement of those arts, by which the labor of man can be aided and rendered more productive, is worthy of the patronage of any government . . . As the benefit to be derived from this institution will be realized by the agriculturalist and the mechanic it may properly be considered in connection with these employments, as promotive of the public interest, and consequently entitled to the public patronage. (January 2, 1823).

Two years later, the law having constituted the Governor a member of the Board of Visitors of the Lyceum, Governor Parris's message discusses it more at length and concludes:

> There was no institution in which those branches were exclusively taught which are particularly applicable to the agricultural and mechanical employments of the people and to the ordinary business of life. The institution at Gardiner will supply this instruction in such a manner, that the individual who seeks knowledge in one branch only of the useful arts will not necessarily be diverted from his paramount object. . . . Such establishments, which have for their primary object the dissemination of useful knowledge among the productive classes of the community, are obviously entitled to liberal support. (January 7, 1825).

The next governor, Enoch Lincoln, whose older brother Levi, as governor of Massachusetts, was responsible for the establishment of our first state geological survey, was also much interested in education, and commented favorably on the work of the Gardiner Lyceum in his message of January 8, 1829. It was during his administration that the last state appropriation for the institution was made.

### THE UNIVERSITY OF VIRGINIA AND THE GARDINER LYCEUM

To associate a state university with a small agricultural school, the very name of which has been forgotten half a century, may seem forced. Yet so striking, in some respects, is the similarity of the Gardiner Lyceum and the University of Virginia that it could not escape the notice of any student of the history of science in this country. They were founded at about the same time, the Gardiner Lyceum opening to students in 1823, the University of Virginia in 1825. Both

depended largely on state aid for support and both, at a time when practically all academies and colleges were directly affiliated with some religious denomination, followed the University of Pennsylvania in remaining free from sectarian influence. The introduction of an elective system in the Gardiner Lyceum has already been referred to, and, as is well known, the University of Virginia was the first collegiate institution in America to adopt this system.

A further resemblance between these institutions is that they introduced, almost a century ago, a system of student self government. The catalogue of the lyceum for 1824 states (p. 9):

> One of the most important subjects, which engage the attention of those, who have the care of a literary institution, is that of discipline. The common methods, from some cause or other, are in a great measure ineffectual, and the fact that they are so under the best instructors, leads us to suppose that something wrong exists in the very principle, upon which they are founded.
>
> These methods have been long in use, were adopted in times very different from the present, and have remained unchanged amid very important revolutions of opinion. They commenced during the prevalence of absolute governments, and are now almost the only vestiges of such governments to be found in countries like our own.
>
> In schools, in which the government is wholly in the hands of the officers, and the students have no part but to obey, they are often subjected to regulations, of which they are not taught the propriety, or which they consider unreasonable, and the result is, they look upon their instructors as tyrants, whose laws it is heroism to disobey.
>
> . . . . . . . .
>
> It is probably to the arbitrary nature of school discipline, which finds no parallel in the political institutions of our country, that we may trace that party spirit in public institutions, which arrays the students in opposition to the government, [and] which oftimes renders obedience unpopular.

The author of the Declaration of Independence himself could hardly have offered a more scathing denunciation of college administrative methods. Indeed, Jefferson's own words in his report to the legislature of Virginia (1 p. 94) seem mild by contrast.

> The best mode of government for youth in large collections is certainly a desideratum not yet attained with us. It may be well questioned whether, *fear*, after a certain age, is a motive to which we should have ordinary recourse.

Jefferson's report and the catalogue of the Gardiner Lyceum further agree in calling attention to the system of student self government then in use in certain English schools.

The most distinctive resemblance between the two institutions is in the fact that both emphasized the practical importance of science, the importance of science in education, and even the relation of science to agriculture. These indeed furnished the very reason for the establishment of the Gardiner Lyceum and they were uppermost in the minds of the founders of the University of Virginia. The attitude of the

"Father of the University of Virginia" on the importance of science in the state (1 p. 89) and of science in education is well known. It is not, however, always remembered that in his original plan (1 p. 83) agriculture was included among the subjects to be taught in the university. Indeed, about the time the Gardiner Lyceum was founded (1822) the Agricultural Society of Albemarle attempted to raise funds for the establishment of a professorship of agriculture in the University of Virginia (8 p. 163). The following quotation taken from the letters sent out at this time by the society and signed by James Madison, then its president and a member of the Board of Visitors of the University of Virginia, undoubtedly represents the attitude of the other university authorities.

> This science [chemistry] is every day penetrating some of the hidden laws of nature and tracing the useful purpose to which they may be made subservient. Agriculture is a field on which it has already begun to shed its rays, and on which it promises to do much toward unveiling the processes of nature to which the principles of agriculture are related. The professional lectures on Chemistry, which are to embrace those principles, could not fail to be auxiliary to a professorship having lessons on agriculture for its essential charge.

A brief quotation from the first "address to the public" prepared by Robert Hallowell Gardiner will show how similar were the ideas of those who founded the two institutions.

> Agriculture, too depends much upon chemistry. It is the business of this science to investigate the nature of soils, the cause of their fertility or barrenness, to ascertain the composition of manure, and the kind best suited to give fruitfulness to each kind of soil. The experience of Lavoisier, who in a few years, doubted his crops, is sufficient to prove the utility of chemistry, when applied to the cultivation of the earth.

In comparing the ideas expressed in the foundation of the University of Virginia and the Gardiner Lyceum, one is tempted to go further and note the similarity of tastes of their founders. They had much in common, a generous hospitality, an appreciation of education and the need of wider opportunities for scientific training, keen interest in farm problems and a love of out of doors. Both even kept careful meteorological records. In political thought, however, they could hardly have been further apart. Indeed, viewed at the distance of a century, Robert Hallowell Gardiner's attitude toward Thomas Jefferson seems like irrational prejudice. The school he established was of the type nearest Jefferson's ideal and had his personal endorsement, the legislature from which the school drew support was overwhelmingly of the party Jefferson founded and was strongly under the influence of his ideas, the very section of the state constitution which authorized appropriations for such purposes was written by the great Virginian and the school at Gardiner was finally wrecked through the pressure of that selfish sectarianism, the power of which Jefferson did so much

to destroy in his own state. Yet throughout his life Gardiner maintained toward Jefferson that attitude of political hostility and personal criticism which was natural in a New England Federalist, who was the son of a loyalist, and a devout churchman. It may be questioned whether Jefferson's partisanship was more generous. It is the more to the credit, then, of these two pioneers in education, that in their interest in education they were ready to forget political differences, that Gardiner sent the prospectus of his school to ex-president Jefferson as well as to ex-president Adams, and that Jefferson, like Adams, sent a "civil answer approving the plan".

## LITERATURE CITED

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2. Benson, Samuel P. Literature in the constitution [of Maine]. Collect. Maine Hist. Soc. 7:241-242. 1876.

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7. Maxcy, Josiah S. A brief sketch of Gardiner's early history. The Centennial of Gardiner p. 23-46, Gardiner, Maine, 1903. (The notes on the Gardiner Lyceum p. 38 were evidently taken largely from the Gardiner Autobiography. There is included a picture of the Lyceum building, from an old print.)

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# THE RESEARCHER IN SCIENCE[1]

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IT is the custom, at this time, for your president to sing his swan-song and make as graceful an exit from his high office as his natural urbanity—or lack of it—will permit. As retiring president I have chosen the theme of The Researcher in Science for the remarks which I have to make. I may say at the outset that they are intended, not for the veteran researcher, not for the blasé professor who has been bored into dumb, unresisting endurance by an endless succession of such addresses, but they are directed to our newly elected members.

To you, our novitiates, this evening is devoted. Yours is a sacred trust. For it is to keep the heart of science throbbing and to see that this mighty, man-made giant, blind and ruthless of itself, is devoted to the safety and the progress of civilization. In your hands and in the hands of those who come after you it is destined to save or to wreck the world, depending upon the outlook you give it, the motives you instill. The terrible catastrophe of science turned to the destruction of man has been vividly before us during the past few years, and what we have already experienced is but the prelude to what will happen if a later war is to be fought.

*You* are to be the leaders of to-morrow and you should get a clear-eyed vision of the fact that a heavy responsibility is to be laid upon you. It is no less than the guidance of civilization. Human society has become so complex that no longer can its conduct be entrusted to the man in the street. It must, if it is not to prove the colossal failure of all time, be delegated to the expert. Without intent to flatter, I wish to impress you with the distinction of your position. You are a chosen few from the large number of students of science in our great university. You have been selected because of promise. Your sponsors believe that they have detected in you the divine spark of creative ability which means new discovery, new understanding, new accomplishment in the realm of nature, promise of leadership. And while I want you to feel the honor of this choice, I desire still more that you realize the responsibility it places upon you. It means that in entering Sigma Xi you are pledging yourself to live up to your full capacity. Your motto becomes *noblesse oblige* no less surely than this became the motto of the born nobleman in the days of knighthood. High ability un-

[1] An address before the Wisconsin chapter of The Sigma Xi.

questionably means increased obligation to make the most of that ability.

The emblem of science is the question mark. If you feel no compelling urge in you to know the how and the why of things, then you are not destined to be a scientist; if you have not the desire in your heart, not only to discover truth but to follow it wherever it may lead, and to turn it to the betterment of your fellowman, then you are not worthy of being a scientist.

In world and national affairs if anything is to be read certainly from social and industrial conditions to-day, it is the truth of the Biblical maxim, "Ye are part one of another. * * * For none of us liveth to himself and no man dieth to himself." It is becoming clearer every day that part of the world can not be in distress and the rest carefree. This truth ranges all the way down from the major to the minor affairs of modern life. Particularly in a democracy it is obvious that all must stand or fall together. In the material things of life, for instance, it is being driven home to us daily through the pinch of shrinking purses and annoying inconveniences that we can not exist indefinitely under the pressure of either the profiteering parasite or the greedy laborer; that we can not have an eight hour day in town and a twelve hour day in the country—a fat daily wage in the one place and a lean one in the other. It is equally plain in the sphere of intellect and good taste that we can not have a cultured aristocracy and a boorish proletariat, a group of exclusive intellectuals intent only upon their own cultivation, and a mass of ignorant "hewers of wood and drawers of water." Society as a whole must have a favorable attitude toward the projects and teachings which result from the concentrated endeavor of men of high mentality; otherwise little can be permanently accomplished. This means that not only must the scientist make his discoveries, but he must carry the public with him if he is not soon to reach the limit of public support. As scientists of the future, then, you will not only have to make researches but you must keep the public educated to the value and the necessity of your research.

As a matter of fact, keeping the public posted on the progress of science is, in my estimation, not such a hopeless undertaking as some of our scientific Jeremiahs would make out. I fully believe that no really great scientific discovery has ever been made in the past or is likely to be made in the future which can not be stripped of its technical jargon and reduced to terms that, in its broader bearings at least, render it intelligible to the ordinary, educated citizen. I am one of those incurable optimists, moreover, who believes that to interest the layman, every new discovery in science need not have some obvious practical use attached to it. Nor do I believe that appeals for popular support need to be based on the economic aspects of science only. For once, at least, I

should like to see some one with the knack of clear presentation and a conviction of the justice of his cause, go before the public with the direct plea of science for its own sake. I believe that the appeal would meet with a cordial response. It is so easy to show that all truth must in the long run redound to the advantage of man in other than material ways, that we lose much of our effectiveness when we confine our arguments for support to those aspects of science which mean merely a fuller purse or a fatter paunch, a more profitable mine or a more effective machine.

We hear not a little in these days about science and the humanities—that is, we hear not a little about them from the professional humanists. The word "science" in this setting is sometimes spoken with a sort of haunting fear as though the downfall of beauty, sentiment, and poesy were at hand. Science and these elusive entities vaguely termed the humanities seem to be regarded as in some way antipodal and antagonistic. To be sure we are told by Trench that the Romans meant by "humanitas" the highest and most harmonious cultivation of *all* the faculties and powers, but their modern successors seem to have changed the inclusive *all* to the restrictive *some*, that is, they apparently exclude the faculties and powers which have to do with science.

When a scientist, seeking enlightenment, makes a determined effort to lay hold upon the idea labeled "humanities," in the broad modern usage of the term, he comes back at last with such morsels as these: cultivation of the emotions and perceptions; interpretation of the soul of man; interpretation of past human experience, emotional, rational, etc.; elevation and refinement of taste; knowledge of human nature as revealed in literature and history; development of ideals; interpreting ideals of beauty; culture.

He may be a bit puzzled by the indefiniteness of his catch, but still all of the conceptions have a familiar look and feel, and he begins to wonder just why they are regarded as the exclusive prerogatives of the non-scientific. He has encountered them all in literature and even more vividly in his attempts to further the cause of humanity by solving the problems of nature. Just because he has an ineradicable conviction that the universe is intelligible if he can only discover enough links of the chain of cause and effect, and is bending his chief efforts toward working out this faith that is in him, he fails to see just where he falls short in his desire to cultivate his emotions, develop ideals, refine his taste, and interpret the soul of man. He has thought all along that these were some of the important things he was doing. In fact he would, I suspect, define the main objects of education about as follows: to learn how to extract knowledge not only from the past, but also from the things around us, and how to use such knowledge; to learn to weigh evidence that we may know how to deal with facts and to evaluate the conclusions of others; to gain understanding of the fundamental laws

of nature that we may work in harmony with, rather than fall a prey to them; to learn to express our thoughts clearly, forcibly, and with a reasonable degree of grace; and to form character and develop an intelligent appreciation of the things which enrich and refine life. To be sure, he does not work much through intuition or pure fancy, or subservience to authority, and he looks somewhat askance upon products of such an origin. He believes furthermore, that the world of the emotions which, I suspect, we unconsciously imply when we talk of the humanities as consoling us in adversity or revealing human life and feelings, is likely to prove an untrustworthy guide unless grounded upon the hard substratum of objective facts. He makes use, for the most part, of what he terms the method of science.

With its mode of procedure in mind, Huxley once defined science as "trained and organized common sense." The method of science is not, then, some abstruse system which is being expounded, nor a recently discovered panacea for mental aberrations. On the contrary, it is as old as the time when a mind first existed capable of distinguishing the relations of things. So common is it that, whether merchant, mechanic, child or scientist, we use it in a simplified way in nearly all our daily occupations. The method has been expressed in words in one form or another by many logicians and educators, that we might, by focussing our attention upon it, recognize its value more clearly and use it for the more economical guidance of our minds. The principle when thus formulated becomes a sort of handrail to our mental stairway which keeps us from tumbling down into the realm of inanity, illusion and superstition. It is one of those great modes of mental activity which, more or less unconsciously, all follow, but which, like steam in a cylinder, become power to a purpose when followed consciously.

When he invades the realm of the humanists, the prying scientist soon discovers that these self-appointed arbiters of culture and humaneness are not in agreement among themselves as to what is the Simon pure brand of their ware. Seemingly, one has almost as much choice in alternatives as he has of styles in theosophy. He finds such major labels as classicism and romanticism together with a whole host of subordinate ones. Clearly, the humanists still have some time to bicker among themselves, apart from that spent in decrying the gross materialism of science and weeping over the vanishing auras of culture. I say auras because, as stated, you can never get them to agree on just what the particular aura is that is being lost.

After one becomes a bit acclimated to this rarified atmosphere one makes the interesting discovery that the real creators in this realm, the poets, philosophers and makers of *belle-lettres*, are not the complainants. Scarcely any one more than the poet, in fact, has made avid use of the findings and doings of science. One needs but to pick up his Tennyson, his Browning or his Kipling to verify this to the full.

But let us admit at once that some scientists are crass, plodding specialists who have neither breadth of vision nor depth of soul. And let us also express the suspicion that some humanists belong in an equally narrow, uncompromising class. Just as there are beetles whose sole place in the scheme of nature seems to be to hunt up dead mice and other small lifeless creatures and either devour or bury them, so there are individuals, apparently, whose idea of culture is the devotions of one's life to devouring the fragments of various dead languages, not with the idea of revealing to their less accomplished brethren whatever there may be of valuable thought or sentiment concealed there, but for the mere joy of the feast. Now no one will deny the useful part the sexton beetle plays in the world, nor does any one doubt the great service the classicist can really do for us when he stops tinkering with the mechanism of language long enough to reveal to us some of the great thoughts conveyed by it. Neither would any scientist quarrel with even the classicist given over entirely to necrophilism if the latter did not keep on insisting that his is the only real portal to culture and beauty.

Am I tilting against a man of straw? Let me cite a specific example. Some time ago I was walking along a ravine through a beautiful park with such an aesthete of classicism. The prevailing trees of the vicinity were giant beeches, and with their fresh new leaves, gray trunks and drooping branches they were a joy to the eye. The ravine itself was bordered with a profusion of the lesser trees and shrubs of the woodland. A shower had just passed and the drops of water still clinging to the leaves flashed back the gold of the late afternoon sunshine. Many of the choicer early spring flowers still lingered in the depths of the ravine—the bloodroot, the wild ginger and the trilium. The evening song of the woodthrush was all around us and a specimen of the rare hermit thrush shyly glided through the underbrush. A trim fox-sparrow eyed us pertly from beneath a nearby shrub. One good deep breath of the newly washed air was like a fresh draught of life. Upon remarking on the beauty of the scene I was met with the rather bored rejoinder, "Yes, but for it to be really beautiful there ought to be pieces of statuary here and there among the trees, and the ruins of a Grecian temple visible in the distance." Then with eyes bent to the bridle-path along which we were strolling he babbled on of beauty.

Verily, if this be a fair sample of what classicism yields, then in preference to it I suspect most scientists would cry, "Back to intellectual Nirvana and an instinctive life with the creatures of the wilderness!" Certainly the picture of the beast-world as Walt Whitman paints it is far more alluring:

They do not sweat and whine about their condition,
They do not lie awake in the dark and weep for their sins,
They do not make me sick discussing their duty to God,
Not one is dissatisfied, not one is demented

With the mania of owning things;
Not one kneels to another, nor to his kind that lived thousands
 of years ago;
Not one is respectable or unhappy over the whole earth.

Fortunately, however, my example is not a fair one, but it is no more unfair than those you see exhibited not infrequently to typify the scientist. Such a classicist demands attention only because of the assiduity with which he fights the intrusion into our educational programs of anything bearing the mark of science, although he himself is often innocent of any knowledge of the subject. It should be well understood that there is no quarrel with classicism itself. Many scientists have a high regard for both Greek and Latin and wish most heartily that their students had had some training in one or both. Aside from the question of other values, the single one of inculcating something of the significance of words is certainly one that appeals to most teachers of biology, for now-a-days the simplest technical term, etymologically considered, is to most of our protégés, as one of my students put it, "only a funny noise." For purely selfish reasons, if for no other, I for one, should like to have students come to me with some knowledge of Greek and Latin roots, and practice in making derivations.

There is another type of less classical demeanor which merits passing attention. Fortunately again this type is relatively rare, though it makes up in obnoxiousness what it lacks in numbers. It professes humanism rampantly, though I suspect that real humanists would disclaim it. It deserves only such diagnosis as will enable us to avoid confusing it with men of real culture and discernment. Like the wise men of Biblical tradition, not infrequently it comes to us out of the East, shedding sweetness and light at every stride. It invariably pronounces *b e e n*, *bean*—lovingly and lingeringly, as though culture sat enshrined in this single word. It is fond of discoursing on the ideals of culture at, let us say, W— University compared with ideals at X— University, from which it sprang; always, of course, to the disparagment of the former. If music, art, literature or philosophy is the theme of conversation, it is always ready with an authoritative dictum—its own—of what's what or who's who in these realms. In its defense, the plea may be made that usually it is young, and presumably it dies early, for it is rarely encountered after its fortieth year. If you meet it, don't be perturbed by its strictures on science; science will survive.

As he listens day by day to the diagnosis of the situation at the hands of his humanistic friends, the scientist hears more frequently perhaps than any other, the word *culture*, and gradually the conviction arises that humanists regard culture and humanism as practically synonymous terms. He suspects, moreover, that some of them feel,

deep down in their hearts, that they have some sort of monopoly on appreciation of the thoughts, deeds and motives of the cultured world of to-day and yesterday. The implication seems to be that in turning to science the misguided one is somehow missing the refinements of life. If you are to believe them, apparently, the scientist can not, in imagination, "wander lonely as a cloud that floats on high o'er hill and dale" because to this literal mind a cloud is only vaporized water, and inanimate things can not be lonely. Nor can his heart dance with the daffodils because strictly speaking *Narcissus pseudo-narcissus* does not dance.

When the wind is low and the sea is soft
And the far heat-lightning plays
On the rim of the west where the dark clouds rest
On a darker bank of haze

should remain a meaningless jumble to him because his mind must inevitably be distracted by the fact that, strictly speaking, the west does not possess a rim. It can not be sweet for him

——to hear the faithful watch-dog's honest bark
Bay deep-mouthed welcome as we draw near home

because, presumably, he regards the dog as only so much laboratory material. If by some mischance he wanders into Southern Italy, he can not be struck with the symbolism of the asphodel, "pale flower of Hades and the dead," which riots over the crumbled walls and around the deserted temples of Paestum, because he must be preoccupied with the knowledge that the asphodel is a plant with fleshy fasicular roots, tufted radical linear leaves, long racemes of lily-like flowers on scapes, and that it is a perennial herb of the family Liliaceae. Besides, there is a suspicion that Paestum, far from having a romantic history, was an ordinary swampy settlement from which the inhabitants were driven by the onslaughts of malaria. Again, his mind must be closed to impressions pictured in the mystical blue lights of unusual fancy—as by Hawthorne in literature or Grieg in music—since fancy is not reckoned as a tool of his trade.

However, the scientist is very likely to meet these implications with the challenge, "What is your evidence, and by what authority have *you* become mentor?" Or in the query of the Israelites to Moses, "Who made thee a prince and a judge over us?" Have you had equal training in the sciences and the humanities, or are you presuming to pass judgment in the matter without really ever getting into the spirit of modern science? In listening during the last twenty-five or more years to the perennially recurrent debate over the relative educational importance of science and the humanities, or more narrowly sciences and languages, I have always been struck by the fact, apart from the intrinsic merits or demerits of the case, that many of the scientists had

a reading knowledge of French or German or both, and could boast at least a passing acquaintance with Greek or Latin, while their opponents rarely knew any science through direct contact in laboratory or field. In fact, in not a few instances the crowning glory of the latter, in their own estimation at least, appeared to be that they had kept themselves unsullied from that world of unrighteousness. Some of them seemed not to have even an inkling of the fact that to understand science is not merely to be aware of or experienced in its material achievements; that it is not only ability to use its tools and on occasion express one's self in the abbreviations which constitute scientific terminology; but that it is also to see in it the struggle of the human mind toward new concepts of nature, and to realize the place of such concepts in the fabric of civilization.

Science has, indeed, a much broader significance than application to immediate ends only. To level one's whole effort to meet the shifting needs of present occupations is, so far as true progress is concerned, clearly suicidal. Science should never be regarded as a mere commodity or means of subsistence. Human progress requires application of our knowledge, to be sure, but we must never lose sight of the great fact that discovery and explanation must precede application. Value of mind must always come above value of money and the first question of the scientist should be, not "Is it useful?" but "Is it true?" If true, then *pari passu* it is useful.

The conventional distinction between pure and applied science is in fact partly academic. A vast proportion of the material advantages of modern civilization rests on results obtained by the scientist unmotived by the immediately practical. Perhaps no conquest of nature is more impressive than that of wireless telegraphy, yet this utilitarian accomplishment was made possible only through the discoveries of Professor Hertz, a pure scientist, in his studies on light and electricity. On the other hand, perhaps nothing has done more to stimulate new researches than has practical wireless telegraphy. Almost any schoolboy can to-day cite striking instances of economic applications of principles or facts discovered without any thought of their utility, and any technologist will tell us that he can not scrape through even the veneer of his practical problem before he heads full tilt into countless other problems which require all varieties of science, pure, impure and mixed in their solution. Thus even the most thoughtless can easily see that to interfere with pure science is to kill the goose that lays the golden egg.

However, I would not belittle the part that our daily bread plays in fostering even the humanities. According to Westermann, the prosperity, and with it the culture of Ptolemaic and Roman Egypt, waxed with increase of wheat production and waned with its decline. Upon the passing of the extensive system of irrigation which had wrested fertile

lands from the desert and maintained them at a high degree of productivity for hundreds of years, the desert claimed its own again, and the brilliant intellectualism of that ancient world vanished.

Not long ago, I heard a historian express his disapproval of a contemporary with the statement that B— was not a historian but a scientist, thus revealing his own conception of a scientist as a mere collector of facts. Instantly there flashed up in my mind the memory of a revered teacher of my young manhood, who, though untiring in his quest for necessary facts and meticulous in his demands for accuracy, held before us the constant reminder that, in his own words, "fact knowledge is the fool's paradise," and that "an ounce of ability to turn facts into general ideas is worth tons of information," and I reflected that my friend the historian still had much to learn about the true spirit and significance of science. It so happened that within less than twenty-four hours a scientific colleague expressed the idea that C— was not a scientist but a mere historian; that is, presumably, a chronicler of events. And I had opportunity to reflect again; this time to the effect that the scientists no less than the historian may be afflicted with seriously myopic vision when he views the other man's domain.

And is not this emblematical of the whole difficulty? Each knows too little of the other's point of view; each misunderstands the other's motives and accomplishments. This is a malady of world-wide range which is not restricted to the supposed conflict between science and the humanities. As we have already seen, it is common within the humanities themselves, and it certainly is prevalent within the sciences. Even in so restricted a realm as that of music we discover no end of disagreements and miscomprehensions. In looking through a reminiscence of Tshaikovsky some time ago, for instance, I was impressed by the fact that although this master of tone-drama—creator of the somber *Manfred* and of the melancholy *Symphony Pathétique*—admired Wagner personally, he expressed his utter inability to grasp what this great artist was trying to do in his music drama. And toward Brahms, who, because of his adherence to established forms, had unwittingly become the champion of the anti-Wagnerian party, Tshaikovsky reveals an actual antipathy, saying that Brahms coquets with the intricacies of musical composition to hide his poverty of ideas. Yet Brahms is almost universally admired by other technical musicians and is regarded as one of the greatest creators of music which is original, beautiful, and of faultless form. With such disharmony of opinion in what is supposed to be the most harmonious of the arts, is it any wonder that the place of science in the realm of human culture may be variously appraised by different cultured people?

Even when we speak or read the same words we may understand by them very different things, since we are almost sure to impute to them meanings derived from our own mental content. How easily this mis-

take can be made was brought vividly to my attention only a few days ago. In an idle moment I had picked up the volume of Thomas à Kempis "Of the Imitation of Christ," and was sampling it here and there. In Chapter 3 of the first book, I chanced upon the expression "And what have we to do with genera and species? He to whom the Eternal Word speaketh is delivered from many an opinion," and came up with a start. To the modern evolutionist, that could only be an echo of the Darwinian controversy, and yet as a matter of fact the volume in question was written in the early part of the fifteenth century, three hundred years before Linnaeus led us toward the modern usage of the words genus and species, and over four centuries before Darwin was born.

It is to a certain extent a matter of opinion, of course, as to what constitutes culture; but in the main, many educated people of to-day will agree that the best culture is that subtle attribute which comes with proper education, simultaneously quickening the intellectual, the moral, and the esthetic sides of man's nature. It is not learning alone, but learning refined into wisdom and intelligent social activity. Matthew Arnold's familiar definition of it as "the study and pursuit of perfection" is known to you all. But he did not limit it to pursuit, for he said we are justified in the quest for perfection only "to make it prevail." His idea of culture was, then, not only acquisition of knowledge, but also its utilization for the betterment of man.

Are we essentially more cultured, if in fancy we watch some goat-legged god go capering through the pastures and forests or along the streams of Arcadia piping to the wood nymphs, than if we actually go into the woods and along the streams in search of our friends in feathers or fur, watching their home-making, learning their habits, understanding the part they play in nature, enjoying their beauty of form, action or song? Are we necessarily more learnedly, ethically or esthetically employed when we are gazing down through the portals of a borrowed mind—say Dante's—into the murk of hell, or ascending with him through the seven planetary heavens to the empyrean, than we are when striving to analyse the obscure motives of man in terms of the behavior of lower animals where many of them stand unveiled, or in studying the part living things play in the world, and man's relation to them, so that his place in nature shall not always remain a sealed book to him? Each type of occupation unquestionably has its own value. Dante, so aptly termed the "voice of ten silent centuries," depicts allegorically the wrestling of man's soul with the problems of human existence; science represents the wrestling of man's reason with the world as it is, to the end that human existence may become based less on fantasy, more on fact.

If proper balance of tone, contrast and color are to be secured in a great orchestra, not one family of instruments—strings, wood-winds,

brass or percussion—can be dispensed with. Think what a hiatus would result between strings and brass if the wood-winds were lacking; or if even the horns, which in orchestral usage merge the wood-winds with the harsher brass, were missing. What could take the place of the trio for horns in the "Eroica," or the horn solo in the scherzo of the "Pastoral" Symphony, or the well-known passage for four horns in "Der Freischutz"? The peculiar tonal quality of each separate instrument, indeed, whether considered individually or in combination with other instruments, is essential to the finished effect. The expressiveness of the bassoon, bass of the wood-winds, is inimitable in certain sustained melodies like that given to it in the Weber Mass in G, "Agnus Dei"; so, too, is its drollery in the hands of good old Father Haydn, or its ghastliness in Meyerbeer's resurrection of the nuns, or Handel's scene between Saul and the Witch of Endor. What else could impart the spirit of gayety, or, on occasion, of melancholy, that that autocrat of the orchestra, the oboe, does? Or what can pander more to savagery in musical taste than the yelping, braying saxophone, hybrid of reed and brass, which so intoxicates our modern devotees of "jazz"? The point I would make is, that just as a great diversity of instruments of distinctive individual and group qualities must be combined to secure the marvelous effects of the symphony orchestra, so the blending of a wide range of sciences and humanities is indispensable to well-balanced modern culture.

Thus no one aspect of learning is sufficient. The study of science in some form should be accorded a prominent place, however, because of its obvious bearing upon the principles involved. It is the most direct of all learning, and from the very necessity of obtaining correct knowledge through personal contact with the facts concerned, it engenders in large degree the ability "to make it prevail." Training in science, therefore, must demand recognition as one of the fundamental components leading to that perfection which, with Arnold, we may recognize as the goal of culture. "Perfection * * * is a harmonious expansion of *all* the powers which make the beauty and worth of human nature, and is not consistent with the over-development of any one power at the expense of the rest."

Even if we choose such aspects of culture as art, we can not escape the fundamental necessity of accurate observation and clear reasoning—the very essence of science—and this is as necessary to literary art as to other forms. For before we can have art in literature, we must first see the truth, then state it accurately and clearly. Walter Pater, one time apostle of precision and fitness in style, says, "Truth! there can be no merit, no craft at all, without that. And further, all beauty is in the long run only fineness of truth." That accuracy in the use of language which must result if one records his observations faithfully, then, must be one of the foundation stones upon which literature as art is builded;

for if we are to believe this critic, fine art in literature results only from the writer's effort to transcribe the essence of the truths which he perceives; not necessarily, to be sure, the actual specific fact, but "his sense of it," and the result is "good art in proportion to the truth of his presentment of that sense."

We sometimes hear the curious assertion that training in science tends to destroy the powers of imagination, that it renders one prosaic. But what has suggested any of our great laws or principles in the world of science, if it has not been a legitimate working of the imagination? It was the imagination of Sir Isaac Newton that led him from the simple perception of a falling body to the great law of gravitation, whereby we have compassed the heavens and are able to follow the celestial bodies with the precision of clockwork. It can be nothing else than the imagination which has disclosed the realm of the imperceptible molecule and atom, or in the discovery of electricity enabled us to outdo Puck in putting "a girdle round about the earth in forty minutes." Or what but the imagination, based on scientific fact, has carried us back step by step peering into the depths of ancestry till we perceive the remotest dead, and has thus enabled us to formulate the great law of organic evolution? In truth, as pointed out long ago by Tyndall in a famous lecture on "The Scientific Use of the Imagination," to science should be attributed a legitimate cultivation of the imaginative faculty rather than its destruction. To flights of pure fancy unhampered by knowledge or common sense, however, science is perhaps less cordial.

And last of all let us take cognizance of beauty, that quality which appeals to, and gratifies, our esthetic sense. Where else than in nature can one find more of that perfection of form or circumstance, of harmonious combination, which is the essence of beauty? Only one trained in interpreting the processes of nature can, in fact, see its greatest beauties. To such a one a graceful tree has a tenfold beauty unsuspected by the casual observer. It is not only a thing of symmetry and of life, a harmony of color, or a picturesque bit of the landscape; it is infinitely more. Its every attitude, every part, is a response to the wonderful energy of the universe. Locked in every leaf is the secret of creation which can wrest life from the sunbeam and embody it to our view. The very arrangement of bough on trunk and leaf on bough points to the silent struggle of each to gain the most favorable position for this transmutation of life. Its roots, prompted by an inner impulse of response to the external world, no less marvelous than that of leaf and bough, thread their way in darkness for the soil-food and water which shall later with the ingestions of the leaves form the mechanism of living substance.

From the standpoint of beauty our wild animals are not only graceful creatures suited to ornament some menagerie or zoological park;

they are not merely a delight to the eye because of form, color or action; but they are also living examples of that higher beauty to be perceived through a comprehension of the marvelous fitness of living things to their environment. One trained to read such records need not stupidly go to a natural history every time he wants to find out the essential facts about some particular animal, for the account of its native haunts, its habits of life, the nature of its friends and foes are before him in the living animal itself. The spotted coat of the forest, the stripes of the jungle or the meadow, the dunes of the desert, the whites of the polar regions, the symmetry and proportions of body, the claws or hoofs, the beaks or teeth, the position of the eyes, the characteristics of the ears, nose or jaws, in short any particular part of the body when taken with the equally obvious context to be read elsewhere in the animal, tells its unmistakable story.

To one who can interpret, the flower, in addition to mere formal beauty and fragrance, has a wonderful history to disclose of ingenious device, which reaches even to the other world of life, the world of sentient beings, and forces bee or butterfly to serve its ends. The trained observer may see, furthermore, in every spear of grass or every forest tree an emblem of triumph; for has not each through endless struggle won victory? It is the understanding of this victory which enables the seeker after truth to pry even into the very inception of all life and form, whether plant or animal, and point the path by which it has arrived at its present perfection.

And not only in the field of animate nature, but in the realm of astronomy with its romance of worlds in the making and worlds in decline, with its myriads of solar systems in incredible gyrations, yet all apparently orderly and harmonious; in chemistry with its wonderful systems of combination and exchange, of creative possibilities that beggar the lamp of Aladdin; in physics, forging ahead with astonishing strides into the solution of matter itself and of all performances of matter; in geology with its ingenious readings of the past in earth shrinkage, crust warping and climatic oscillations, with its re-creation for us of successive ages of flood and ice, land and sea, of strange monsters long since vanished; in all of these there are worlds upon worlds of beauty unsuspected by those who are strangers to the paths of science.

Thus from the standpoint of esthetics, nature becomes to the student a wonderful harmony. As he perceives something of the mechanism of the universe, how each part moves cog within cog in marvelous unity, knowledge does not reduce his emotional enjoyment, but enhances it through a higher sense of beauty.

When all is said and done, after admitting that many scientists have their crudities and some humanists their asininities, we must realize that science and the humanities have far more in common than they have apart. The old idea of conflict between them is largely fictitious.

They are or should be cooperants, not antagonists. For the most part they look toward the same problem, in last analysis the great problem of what is worth while for humanity. They but view it from different angles. And it will be a sorry day, not only for science but for civilization itself, if scientists ever lose sight of the humaner aspects of their problems. It is my serious conviction, indeed, that one of the imperative, outstanding duties of the modern scientist is to do away with what remains of the no-man's-land between these two great aspects of human culture and blend them into one. No one more than the thoughtful scientist recognizes to-day that science in the sense of mere material accomplishment, of greater accumulation of knowledge, or of more precise logic—if this be all—is futile; it must be humanized. Without the final touch of human altruism, science may easily become a soulless Moloch which will devour its own creators.

Further applications of scientific knowledge unquestionably will mean growing complexity of social organization. And our organization is already so intricate that a slip anywhere in the machinery, be it but the obstinacy of a few striking switchmen or the discontent of a handful of coal miners, may throw the whole machine into disorder. With the dependence of one upon another to which we are becoming more and more committed, serious disruptions of the system become increasingly probable and increasingly hazardous.

In his more pessimistic moods, when he ponders the trend of present economic and social conditions, the mind of the evolutionist harks back to the grotesque monsters of Mesozoic times whose very hugeness probably led to their final extinction, and he is filled with apprehension for the outcome of the human race. This much is sure, human society will need all of brotherly love, all of tolerance, all of the refinements of existence that scientists and humanists can muster jointly, if the giant organism known as civilization is not to succumb to its own intricacy.

It becomes your duty then as a part of the rising generation of scientists to do your share toward imbuing science with a soul, and one of the easiest ways of doing this is to help promote the humanities as you do your science, in every way you can. The relation of man to his fellowman is no less important than the relation of man to his physical environment. Recognizing as we companions of Sigma Xi do that research is the highest form of human activity, let us not take a narrow view of it. The goal of science and of the humanities alike is truth.

The desire for truth, indeed, is a well nigh universal human attribute. The many observances and beliefs common to all the great religions symbolize the cravings of the human mind for truth. Thus the Vedanta maintains that the final deliverance of the soul from its burden of repeated carnal existence can be attained only by the removal of ignorance. In the teachings of Zoroaster we find that chief among the "worshipful ones" who guide the forces of nature is Mithras, per-

sonification of light and truth. And as for the Buddha, his very name comes from a word which means "he to whom truth is known." More familiar still is the pronouncement of the gentle Nazarene, "Ye shall know the truth, and the truth shall make you free."

The great poet, the true artist, the sincere novelist is striving in *his* way for truth, for reality, in no less a measure than is the physicist or the chemist. And the most cursory glance into the past shows that this has been so thoroughout all history. We find Aeschylus, five centuries B. C., grappling in his poetry with a conception of the mental evolution of man. His graphic description, in his *Prometheus Bound*, of the part number and the rudiments of science played in the awakening of man from blind instinct into reason is well worth considering (translation of Elizabeth Barrett Browning):

> How, first beholding, they beheld in vain,
> And hearing, heard not, but, like shapes in dreams,
> Mixed all things wildly down the tedious time,
> Nor knew to build a house against the sun
> With wicketed sides, nor any woodwork knew,
> But lived, like silly ants, beneath the ground
> In hollow caves unsunned. There came to them
> No steadfast sign of winter, nor of spring
> Flower-perfumed, nor of summer full of fruit,
> But blindly and lawlessly they did all things,
> Until I taught them how the stars do rise
> And set in mystery, and devised for them
> Number, the inducer of philosophies,
> The synthesis of Letters, and, beside,
> The artificer of all things, Memory
> That sweet Muse-mother.

Somewhat later we note the endeavors of Plato to make knowledge and conduct go hand in hand, and in his pupil, Aristotle, we see perhaps one of the most ideal combinations of scientist and humanist in one that history reveals. Still farther down the ages we find Lucretius not only propounding a theory of the confluence of atoms into stable and adapted forms, but even foreshadowing the idea of a struggle for existence, the conception which became of such importance in the Darwinian theory. Thus, " * * * And many races of living things must then have died out and been unable to beget and continue their breed. For in the case of all things which you see breathing the breath of life, either craft or courage or else speed has from the beginning of its existence protected and preserved each particular race. * * * In the first place, the fierce breed of lions and the savage races their courage has protected, foxes their craft, and stags their proneness to flight."

With all of these, as with the scientist to-day, the unmistakable note is the quest for truth. So that we scientists in our pre-occupation with

our own fragments of truth must not overlook the fact that the expressions of human emotions, character, taste, and cultivated imagination, all have their share in the finished product of our search. In fact, when we stop to consider, it is obvious that the motives for our conduct, our likes and dislikes, lie far more in the realm of the emotions than in that of the intellect. And all history implies that man can no more live without beauty than he can live without bread.

> Beauty is truth, truth beauty—that is all
> Ye know on earth, and all you need to know.

Even the prehistoric cave-man showed his craving for beauty in crude attempts at picture-making. The colored drawings may still be found on the walls of his caves. The warring, pirating Greeks bore a Winged Victory at the prow of their boat. In the Middle Ages, while the shepherds of the church were burning heretics, great artists were painting Madonnas, great architects were erecting magnificent cathedrals to the glory of God, great writers were giving voice to the tortured, struggling, inarticulate soul of humanity. Seek any period in history, no matter how sordid, how tyrannical, how merciless man in the aggregate may have become; there was always abroad somewhere in the land the spirit of beauty, the leaven of humaneness which in the end redeemed the whole.

> And where is he shall figure
> The debt, when all is said,
> Of one who makes you dream again
> When all the dreams were dead.

And we may note to good advantage also that our knowledge of such facts as these has come down to us mainly through the efforts of humanists. Without them what indeed should we know of "the beauty that was Greece and the grandeur that was Rome?" The nations themselves have long since passed into the night, but their thoughts, their motives, their accomplishments have been added to our own civilization, thanks to the tireless efforts of our classical scholars. And who shall say how much of the efforts of these scholars was science, how much humanism?

As a matter of fact, the reconciliation of science and the humanities, in spite of complainants sometimes heard to the contrary, is already in progress. This is evinced, on the one hand, in the increasing drafts the humanists are making on the methods and materials of science, and through their tacit or avowed acceptance of the worth of science and, on the other, by the spirit of greater tolerance exhibited by scientists. Even in the short period between the present and the close of the nineteenth century, one can notice a decided change of attitude on the part of science. The cocksureness and belligerency of the earlier period has softened into a willingness to reconsider evidence and a spirit of friendliness towards all types of scholarly endeavor. To-day, while his at-

tempt to explain things mechanistically does not falter, the scientist recognizes more clearly the limits of possibilities.

The reason for his earlier attitude, however, is not far to seek. In the last century, particularly following the proclamation anew of the theory of organic evolution by Darwin and his followers, science in general, though especially biological science, suffered the fierce onslaught of the powerful leaders of the day, the clergy, who saw their authority challenged, their privileges threatened. Driven to fight this hostile element for the very life of science, the result was just what might have been expected—the exaggerated dogmatism of a Haeckel or the caustic tongue of a Huxley. The latter, with his crystal-clear style of presenting the facts of science, his bulldog pugnacity and his quick wit, was particularly effective. Now we find him urging one of his hecklers who could or would not understand what he was saying, to use the full length of his ears and he would surely understand. On another occasion, in his famous tilt with Bishop Wilberforce, he expresses his preference for a respectable monkey as an ancestor to relationship with a bigoted bishop who uses his great gift to obscure the truth. Again we hear him pronouncing the conviction that "Extinguished theologians lie about the cradle of every science as the strangled snakes beside that of the infant Hecrules." Such retorts as these show what the provocation must have been, and it requires little further exercise of one's powers of inference to discover why the science of the nineteenth century had the ring of dogmatism. Unquestionably the modern researcher has Huxley to thank for much of his own immunity from such attacks.

But to-day the clergy have come to see that a God of an orderly universe is quite as acceptable as a God of an arbitrary chaos. The educated clergyman now recognizes the importance and more or less of the significance of science, even of evolution, and is finding more than enough to keep him busy in the immediate problems of the human soul without worrying so much about its future. He is content to give us help in the present instead of hell in the hereafter. His aid in keeping the spirit of altruism alive in the world, in upholding ideals, in winning men from the fiercer passions of life, was never more needed and never more tolerantly and wisely given than it is to-day.

But as scientists we are not so much interested in the duties of some other profession as we are in our own. The only excuse I would offer for stepping outside bounds is that if we are to have perspective in our work, if we are to secure a clear vision of future world problems we must see these problems from various points of view and realize that our duty is not done, our fullest possibilities are not realized, until we have fitted our findings as researchers into this general scheme of things. To have but a narrow angle of vision is to miss most of the

richness of life and much of the good we can do for our fellowman. We want to escape the type of accuracy exhibited by the literal-minded printer who, upon coming to the quotation, "Sermons in stones and books in running brooks," corrected it to read "Sermons in books and stones in running brooks."

To each of you as researchers civilization is entrusting its future. It is yours to do great deeds, to dream great dreams. And you may well remember that "the dreamer lives forever while the toiler dies in a day." To most of you will come the seemingly small, but actually the fundamentally important duty of making accurate records of observations and conclusions, together with necessary qualifications and limitations. This is indispensable as a foundation for one's own scientific procedure and is equally important as the basis of fact from which others may take up the duties of discovery after the recorder has passed away. To some of you may be given that rare vision which will enable you to weave together from the ever accumulating strands of scientific truth some new far-reaching generalization. But whatever your part, be it great or small, be assured of its dignity, of its worth, as long as it is honestly performed. You may not live to see the great poet honored more than the successful politician, nor the great scientist more valued than the wealthy trader, but you can at least throw the weight of your influence into the proper scalepan. Yours is a rare opportunity to create, to produce, and I know of no better admonition to urge upon you than this sentiment expressed in the clarion call of Carlyle:

> "Be no longer a Chaos, but a World, or even Worldkin. Produce! Produce! Were it but the pitifullest infinitesimal fraction of a Product, produce it, in God's name!"

In closing, may I urge again that for the researcher, ideals as well as achievements are indispensable to progress, and that both must often run far in advance of what for the moment may seem practical. If the world is to be ruled by truth rather than by tradition and the chance compensation of errors, you and others like you who are entering into the scientific communion of Sigma Xi must give up your life to continuous processes of thought and experimentation. Since the creative mood demands quiet, poise and concentration, you will have to make a constant fight to see that your strength and ability are not drained off by trivial and irrelevant demands into non-productive channels. You will doubtless be called upon to make financial sacrifices. And your reward? Your reward will be consciousness that you have fulfilled your real function of discovering truth, diffusing knowledge and developing ideals.

> Have I named one single river? Have I claimed one single acre?
> Have I kept one single nugget—(barring samples)? No, not I,
> Because my price was paid me ten times over by my Maker.
> But you wouldn't understand it. You go up and occupy.

And while I am quoting Kipling, I shall leave this other bit with you as voicing the real spirit of the researcher:

Till a voice, as bad as Conscience, rang interminable changes
On one everlasting Whisper day and night repeated—so:
"Something hidden. Go and find it. Go and look behind the
Ranges—
Something lost behind the Ranges. Lost and waiting for
you. Go!

# FEARSOME MONSTERS OF EARLY DAYS

By Dr. LEON AUGUSTUS HAUSMAN
CORNELL UNIVERSITY

THE reading of natural history has ever been a popular pastime among young and old. As living beings we are supremely interested in the phenomenon of life; first as it is manifested in creatures of our own kind, and second as we see its animating power vitalizing the many animal forms about us. We take keen delight, moreover, in hearing accounts of the curious and the strange; in listening to tales of hunters of big game as they tell us of extraordinary creatures in lands beyond the sea, or in reading the narratives of whalers who describe the habits of the monsters of the deep. We know much, in general, concerning the animal life of the world today, at least concerning those creatures large enough, or common enough to have made their presence known to man. Through the medium of photography, through the collections of living forms in our zoological gardens, and through foreign travel, we have become familiar with the appearance of many creatures, with which we would not otherwise have been acquainted.

The peoples of earlier days, however, were less fortunately situated with respect to ease of acquiring natural knowledge. Their sources of information in this field were a meagre collection of works, compiled in the main from the ancient writers, and the tales of a limited number of credulous travelers.

Few persons, perhaps, know with what sort of creatures the world of the early naturalists was populated. Doubtless many of us remember the tales of the griffin, unicorn, dragon, and others, which were told to us out of the old rhymes and fairy stories of our childhood. These were glorious creatures, never failing to appeal to the imaginative instincts which make childhood so attractive a period to us as we look back upon it from the world of unpoetic realities! The dragon and unicorn and their ilk, have survived the times and have passed into the literature of the race. But they represent only a fraction of the vast host of marvelous creatures, whose names and attributes are now known only to scholars; creatures in whom the early writers and their readers placed full confidence; creatures which were soberly discussed and pictured in the early volumes of natural history.

Books on natural history were extremely popular in the fourteenth, fifteenth, and sixteenth centuries; and as soon as the art of printing (introduced about 1450) had made available to a large number of


FIG. 1. TITLE PAGE OF EDW. TOPSELL'S "HISTORIE OF SERPENTS"

readers the works of the early naturalists, interest in the fearsome creatures reported from strange lands beyond the sea and little known oceans became widespread. This is not surprising. Many of these early works were embellished with illustrations which could not fail to catch the eye and enchain the interest, even of the most casual. And then the text! Even today, who can read, for example, these words from the famous "Voyages and Travels of Sir John Mandeville" without a thrill of wonder, so convincing is the exuberance and certainty of the glowing phraseology! The passage I quote is from that portion of the "Travels" in which the author is describing the inhabitants of various islands, or "yles", as he calls them, in some far southern ocean:

And in another yle are foule men that have the lippes about the mouth so greate, that when they sleepe in the sonne they cover theyr face with the lippe. And in another yle are lytte men, as dwarfes, and have no mouth, but a lyttle rounde hole & through that hole they eate theyr meate with a pipe, & they have no tongue, & they speake not, but they blow & whistle, and so make signes to one another. In Ethiope are such men as have but one foote, and they go so fast yt is a great marvaill, and that is a large foote, that the

shadow thereof covereth ye body from son or rayne, when they lye upon their backes; and when theyr children be first borne they loke like russet and when they waxe olde then they be all black.

It appears that the most credulous times were during the fourteenth, fifteenth and sixteenth centuries. No tales which travelers brought from remote lands or seas, no statements taken out of early writers, were too gross for belief. Quite naturally the less accessible the lands from which the travelers returned, the less frequented the seas over which the adventurous mariners voyaged, the more grotesque and fearful were the monsters reported as having been seen, partially seen,


FIG. 2. TITLE PAGE OF ALBERTUS MAGNUS' "THIERBUCH"

or heard of. The natural histories of these days were not, it can be seen, records of careful observations by trained observers. They were a mixture of travelers' tales and compilations of earlier authors. Much of this compiled material was from Pliny, who in his turn had drawn upon Aristotle, and others. The "physiologus" and the various bestiaries also furnished an abundance of animal anecdote, chiefly mythical.

These early books are by no means dull reading, even today. They teem with curious anecdotes concerning all sorts of marvelous creatures,

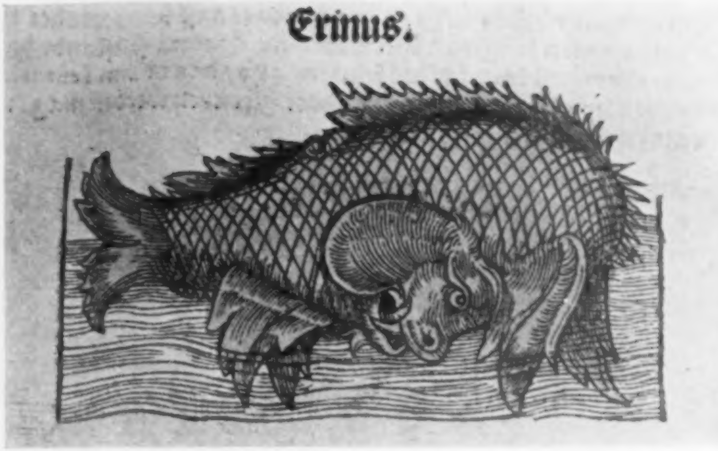



FIG. 3. THE ERINUS FROM ALBERTUS MAGNUS' "THIERBUCH"


FIG. 4. THE ZEDROSUS, FROM ALBERTUS MAGNUS' "THIERBUCH"


FIG. 5. THE UNICORN, FROM EDW. TOPSELL'S "HISTORIE OF FOUR-FOOTED BEASTES"

creatures who are described either as of positive benefit to man or as of positive evil. Note for example the naive way in which Topsell, in the title page of his "Historie of Serpents" (Fig. 1) describes them as bearing "deepe hatred to Mankind." The title page referred to also gives us a hint of the manner of compiling these early natural histories, for Topsell tells us that his accounts are, "Collected out of diuine Scriptures, Fathers, Phylosophers, physitians, and Poets: amplified with sundry accidentall Histories, Heirogliphicks, Epigrams, Emblems, and Aenigmaticall obseruations." Who can doubt that a book heralded by so enticing a title page would engross the interest of even the most casual general reader? And the frontispiece! Could anyone pass over it in apathy? Would not the terrible Boas here shown be the ogre of childhood, the fear of the traveler, the subject of countless discussions and yarns among all sorts and conditions of men? In comparison with some of the marvelous "beastes" of primitive zoology how insipid and uninteresting are our "real" creatures of today. How can even a ninety-foot sperm whale, blowing his column of pearly spray high in the air, compete successfully in interest with a fire-breathing dragon, whose scales were of gold, and who withered and blasted by his very glance?

The illustrations in this article were photographed from several of the most important of the early works on natural history, books which are now extremely rare and to be found only in college libraries or in extensive collections. They represent creatures, which, in the opinion

of the writer, touch the pinnacle of the absurd in imaginative zoological conception. With the exception of the unicorn and the basilisk, they are practically unknown except to students of the history of zoological thought.

It must not be supposed that the only interest attaching to these curious creatures of bygone days is in the amusement they afford. To the historian of zoology they are significant as indicative of various epochs in the development of biological conceptions.

With the unicorn and the sea-serpent (Fig. 7) we are already somewhat familiar. In Fig. 5 is shown Topsell's superb illustration of the former, and surely no unicorn figured in any of the other early writers, rejoiced in the possession of a more impressive horn? In this figure is also shown a portion of the quaint old text. Topsell's phraseology is most rich quaint, and yet graceful. Listen, as he discourses "of the Unicorne' " . . . by the Unicorne wee doe understand a peculiar beaste, which hath naturally but one horne, and that a very rich one that groweth out of the middle of the foreheade. . . . Likewise the Buls of *Aonia* are saide to have hooves and one horne growing out of the middle of their foreheads. . . . Now our discourse of the Unicorne is of none of these beasts for their is not any vertue attributed to their hornes." He tells us that there is a "vertue" in the horn of the unicorn, but that there are many who cannot believe that this is so. Of this "vertue," he say, "ther were more proofes in the world, because of the noblenesse of his horn. . . . they have ever been in doubt: by which distraction it appeareth unto me that there is some secret enemy in the inward degenerate nature of man, which continually blindeth the eies of God his people from beholding and beleeving the greatnesse of God his workes."

The Gorgon (Fig. 6) is another of Topsell's famous illustrations, to be found on the title page of his "Historie of the Four Footed Beastes".

FIG. 6. THE GORGON, FROM THE TITLE PAGE OF EDW. TOPSELL'S "HISTORIE OF FOUR-FOOTED BEASTES"

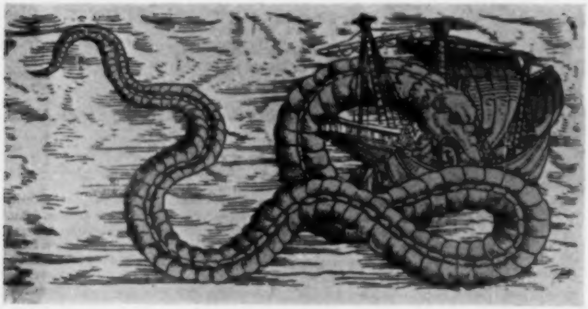


FIG. 7. THE SEA SERPENT, FROM KONRAD GESNER'S "HISTORIAE ANIMALIUM," COPIED FROM OLAUS MAGNUS

Topsell's chief interest was in the larger forms of animal life, as his work, in two parts, attests.

In Ulysses Aldrovandus, however, we find a naturalist to whom the lowlier forms of life made more appeal. His tremendous folio volume on insects and other primitive creatures, published in Latin in 1602, contains many curious forms not known to zoologists of the present day. Fig. 8 is one of these bizarre forms, a snail, whose remarkable fore limbs are of no less anatomical interest than they are of artistic conception. It is a curious and noteworthy thing how often the early naturalists depicted their beasts with these rather pleasing, leaf-like appendages, slashed into fringes and lobes. No doubt they thought that this gave an artistic "finish" to the beasts, as it indisputably does. In this connection compare the appendages of the creatures in Fig. 9 with Erinus (Fig. 3) and Zedrosus (Fig. 4).

The sea-serpent has been with us from time immemorial and in some sections of the country belief in it still lingers with tenacious hold. Fig. 7, taken from Konrad Gesner's "Historiae animalium" shows a mediaeval conception of this terror of the sea, a conception which certainly depicts the serpent in all his fabulous terrors. Note the ease with which he arches his back and selects out the fattest seaman of

FIG. 8. A UNIQUE SNAIL, COCHLEA, FROM ALDROVANDUS' "DE ANIMALIBUS"

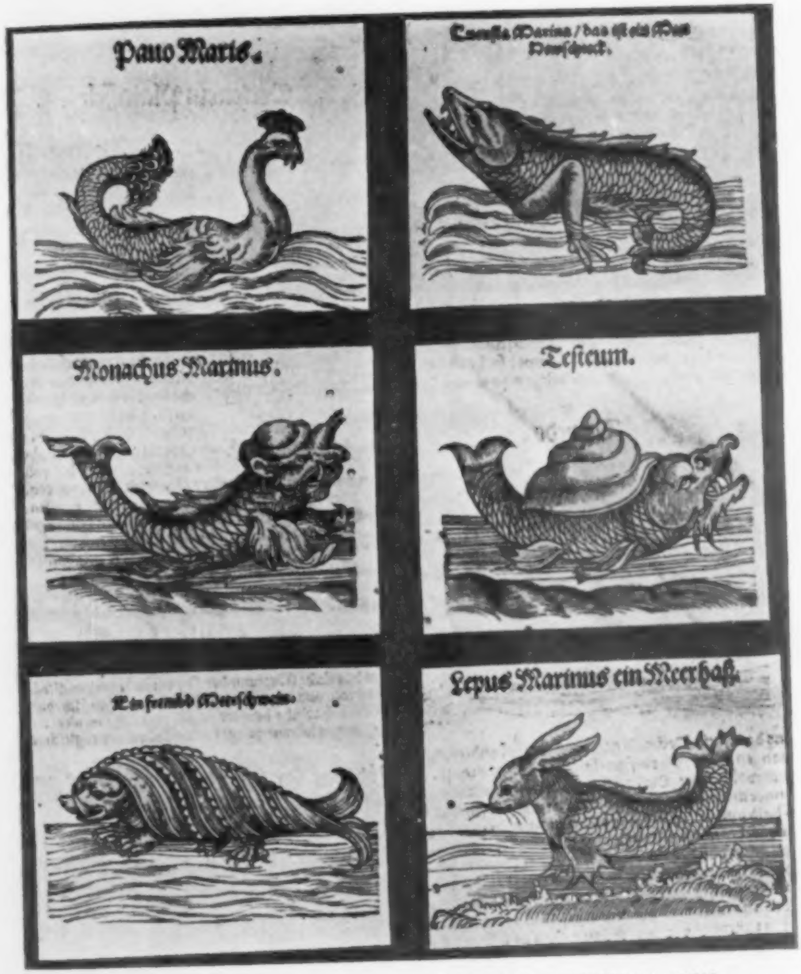



FIG. 9. A GROUP OF SEA MARVELS OR "MEERWUNDERN," FROM ALBERTUS MAGNUS' "THIERBUCH"

the crew of the helpless vessel. Of illustrations of sea-serpents there are legion. This one I have selected as fulfilling perhaps our most morbid notions of a creature, than whom nothing more awful exists in the sea of our imagination.

FIG. 10. AN ASSORTMENT OF "DRAGONS AND CHIMAERAS DIRE," FROM ALBERTUS MAGNUS, TOPSELL, ALDROVANDUS AND GESNER

Dragons, chimaeras, basilisks, cockatrices, and gorgons, seemed to have exerted a by no means meagre fascination for the early writers. Accounts of them are numerous and lengthy in almost all of the old works. Nor were their habits less strange than their forms. Of fierce and vindictive dispositions, in league often with the Evil One himself, breathing fire, and blasting or killing by their very glance or touch, they formed a theme upon which the credulous old naturalists were never tired of descanting. In Fig. 10 is shown a group of typical "dragons and chimaeras dire" from Albertus Magnus, Aldrovandus, Topsell, and Gesner. Topsell in his long discussion of dragons, says of one sort: "Their aspect is very fierce and grimme, and whensoever they move uppon the earth, their eyes give a sound from theyr eyeliddes, much like unto the tinckling of Brasse. . . ." And again, speaking of the classification of dragons he says: "There be some dragons which have wings, and no feete, some again have both feete and wings, and some neither feete nor wings, but are onely distinguished from the common sort of Serpents by the combe growing uppon their heads and the beard under their cheekes."

Those, however, who wish to be ushered into a world more populous in bizarre and marvelous animal forms than any other of which the writer is aware, have but to open the magic door of Albertus

Magnus' immortal "Thierbuch," unfortunately for those who read no language but English, written in rather antiquated German. A copy of this rare work (printed in 1545), in heavy embossed leather with brass clasps, and riddled with bookworm holes, fell into the author's hands recently. From it were photographed the title page (Fig. 2) and the "Meerwundern", or sea marvels (Fig. 9), Albertus Magnus begins his pretentious work with the story of Adam and Eve (so as to be certain that he makes a start from the very beginning) and then follows this with accounts of all sorts of creatures; accounts illustrated with figures beautifully drawn, and embellished, in many cases, with artistic flourishes of the artist's own. In the figure of the Zedrosus (Fig. 4) is included some of the text, a beautiful example of the artistic typography of the times. The letters are clear, bold, and easily read, and the style of the font of type pleasing in its proportions. In Fig. 9 is shown a group of sea marvels, or "Meerwundern", a title which no one would presume to dispute. In the writer's opinion, however the Ultima Thule of absurdity is attained in the conception of the beast Erinus (Fig. 3). Albertus (no wonder he was accorded the title of "the great") says of this creature: "Erinus is also a fish in the water which has its mouth and face bent down under itself, and the opening for the excreta located above." He tells us that, according to Pliny it is feared by other fishes, and that its flesh is red, like cinnabar. Truly a fearful "Wunder" was the Erinus.

It might appear that the author is in sympathy with the early writers only when they happen to afford amusement. This is far from being the case. No one can read the early writers without a smile, it is true; nevertheless he is a blind reader indeed who cannot detect the true purpose of these sturdy though credulous old naturalists, who cannot perceive that their one ambition was to further the bounds of natural knowledge, to glorify the Creator by showing forth the wonders of His works, and lastly, and in this case also least, to acquire some renown for themselves.

In conclusion listen to these words of Topsell, in his Epilogue to the "Historie of Four Footed Beastes":

> If you think my endeavors and the Printers costs necessarie and commendable, and if you woud ever farther or second a good enterprise, I do require al men of conscience that shall ever read, hear, or see these Histories or wish for the sight of the residue, to helpe us with knowledge, and to certifie their particular experiences of any kinde, or any one of the living Beastes: and withall to consider how great a task we do undertake, travelling for the content and benefit of other men, and therefor how acceptable it would be unto us, and procure everlasting memorie to themselves to be helpers, incouragers, ayders, procurers, maintainers, and abbettours, to such a labor and needfull endeavor, as was never before enterprized in England. .

MEDAL IN HONOR OF DR. STEPHEN SMITH

The plaque (photographed by Paul Thompson) from which the souvenir medal in honor of Dr. Smith was made. It was modeled by Michele Martino, the New York sculptor.

# THE PROGRESS OF SCIENCE[1]

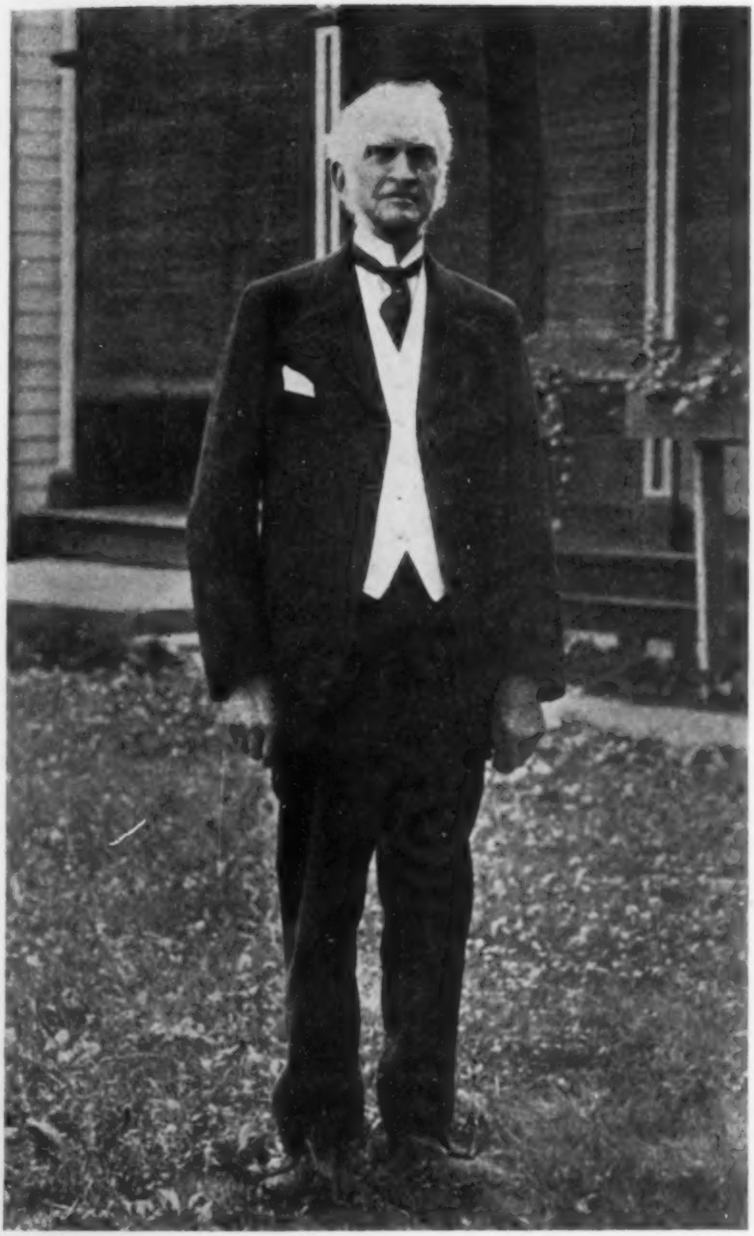
## THE AMERICAN PUBLIC HEALTH ASSOCIATION

New York has been the scene of semi-centennial meetings of the American Public Health Association from November 8 to 19. During the first week, there was a public health institute which included demonstrations on vital statistics, hygiene of mother and child, public health nursing, socio-health, sanitary engineering, communicable diseases, laboratory work, food and drugs and industrial hygiene. This was the occasion for visits to clinics, stations, institutions, centers, laboratories, hospitals, water and sewage plants, and other public health activity centers in New York City and its vicinity.

During the week of November 14, the largest health exposition ever attempted was held at the Grand Central Palace through the cooperation of the American Public Health Association and the Department of Health of the City of New York. This exhibit was marked by many novelties, such as children's health games, fat reducing squads, perfect baby contests, perfect teeth and foot contests. Social service and scientific organizations joined in the exhibition. Among them were the National Tuberculosis Association, the National Health Council, the American Social Hygiene Association, the American Museum of Natural History, the American Society for the Control of Cancer and the National Committee for Mental Hygiene.

The fiftieth annual meeting of the association, held from November 14 to 18, included both general and scientific sessions. Representatives from Canada, Cuba and Mexico, as well as all parts of the United States, were in attendance. Dr. Mazyck P. Ravenel, as president of the association, delivered the principal opening ad-

[1] Edited by Watson Davis, Science Service.



**DR. STEPHEN SMITH**

Founder of the American Public Health Association, which is now celebrating its fiftieth anniversary. Although 99 years of age, Dr. Smith is active in the work of the association.

dress. The scientific papers and addresses included a wide variety of subjects under the general topics of public health administration, laboratory work, vital statistics, food and drugs, sanitary engineering, industrial hygiene, child hygiene, health education and publicity. In commemoration of the semi-centennial celebration, the association is also publishing a jubilee historical volume.

Attending these sessions, and guest at a banquet in his honor, was Dr. Stephen Smith, who fifty years ago founded the American Public Health Association and became its first president. Though now ninety-nine years old, Dr. Smith still takes an active part in the affairs of the association. He was further honored during the health fortnight by a souvenir bronze medal bearing his portrait and fittingly inscribed to denote his participation in the fiftieth annual meeting. In addition to his activities in the American Public Health Association, Dr. Smith has been a leader in city and national health work. He is the author of books on surgery and other medical subjects and before the Civil War was editor of several medical journals. As surgeon, he has served Bellevue Hospital many years, and in 1896 he represented this country at the Ninth International Sanitary Convention.

## SCIENTIFIC PROBLEMS OF THE PACIFIC

The Pacific Division of the American Association for the Advancement of Science at its recent meeting in Berkeley endorsed the idea of the Washington Conference on the Limitation of Armaments and Pacific Problems and offered the services of scientific men to the President of the United States for solving such Pacific problems as may require expert scientific knowledge.

Dr. William E. Ritter, director of the Scripps Institution for Biological Research, La Jolla, California, writes:

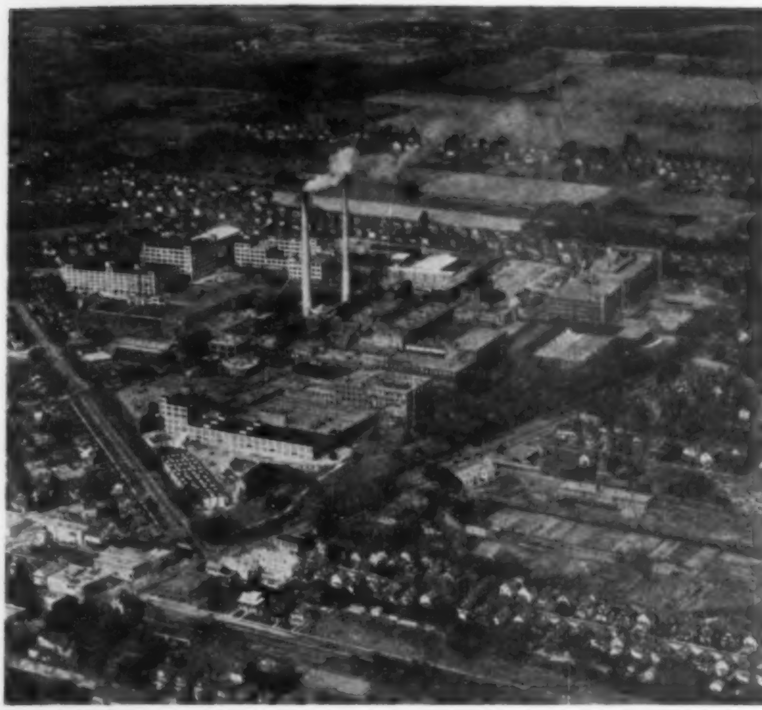
The resolutions adopted had two aims. One was generally informative. It would let the government and people of the United States know, so far as it might, where the scientists thus expressing themselves stand relative to the purposes of the conference. The hope was that the resolutions would do something toward correcting the belief, now too prevalent, that science is in effect more favorable than unfavorable to the militaristic type of international dealing. The other aim was more concrete. It would make scientific knowledge and research, and technical skill, positive factors in solving international problems by intelligence, which usually follows the way of peace, instead of by emotion, which usually follows the way of war.

The National Research Council has a committee on Pacific Investigations composed of: Herbert E. Gregory, chairman, Bishop Museum, Honolulu, Hawaii; T. Wayland Vaughan, vice-chairman, United States Geological Survey; William Bowie, United States Coast and Geodetic Survey; Barton W. Evermann, California Academy of Sciences; John C. Merriam, Carnegie Institution of Washington; William E. Ritter, Scripps Institution for Biological Research; W. T. Swingle, United States Department of Agriculture; and Clark Wissler, American Museum of Natural History.

## GOVERNMENT EDUCATIONAL COURSES

Two scientific branches of the government are helping their scientific staffs to become more useful to themselves and to the government by offering the opportunity to take courses of graduate study after office hours.

For more than ten years the Bureau of Standards has been maintaining advanced courses in physics, mathematics and chemistry, and this year the Department of Agriculture has inaugurated a system of advanced instruction in those scientific and technical subjects related to the work of the department in which adequate instruction is not available in Washington.



AN AIRPLANE VIEW OF KODAK PARK, THE PLANT OF THE EASTMAN KODAK COMPANY

It is expected that the successful completion of any of the courses will be recognized for adequate credit in some of our better educational institutions, both for undergraduate and for postgraduate work. This has already been the case with the Bureau of Standards courses.

Those offered this year at the Bureau of Standards include: Advanced optics by Dr. C. A. Skinner; differential equations by Dr. L. B. Tuckerman; chemical thermodynamics by Dr. L. H. Adams of the geophysical laboratory; interpretation of data, including the theory of errors and methods for numerical, graphical and mechanical computation, by Dr. Chester Snow.

The courses of study at the Department of Agriculture were worked out by a committee from the various bureaus of the department headed by Dr. E. D. Ball, formerly assistant secretary and now director of the scientific work of the department.

There are two more or less distinct kinds of work offered: (a) lecture and drill courses on certain fundamental subjects in which the personnel of two or more bureaus may be interested; (b) intensive graduate training in special topics.

The courses now being given at the Department of Agriculture are: Agricultural Economics, by Dr. H. C. Taylor; Statistical Methods, by H. R. Tolley; Biochemistry, by Dr. C. O. Appleman; Mycology, by Dr. C. L. Shear; Plant Physiology, by Dr. Burton E. Livingston; Genetics, by Dr. Sewall Wright; Physics of the Air, by Dr. W. J. Humphreys; Statistical Mechanics applied to Chemical Problems, by Dr. R. C. Tolman.

## THE OPTICAL SOCIETY OF AMERICA

At the sixth meeting of the Optical Society of America, held in Rochester, N. Y., the most notable feature was the Helmholtz Memorial Meet-

ing held on the afternoon and evening of October 24. The afternoon program was as follows:

*A brief survey of the historical development of optical science*: PROFESSOR J. P. C. SOUTHALL.

*Helmholtz's early work in physics—the conservation of energy*: PROFESSOR HENRY CREW.

*Helmholtz's contributions to physiological optics*: L. T. TROLAND.

Professor Crew exhibited lantern slides showing Helmholtz at the time he wrote the essay on the Conservation of Energy (age 26) and also at later periods of his life.

At the evening session, Professor M. I. Pupin spoke informally and in a most interesting and delightful manner on his Personal Recollections of Helmholtz. Professor E. L. Nichols, Professor Ernest Merritt, Dr. Ludwik Silberstein, Mrs. Christine Ladd-Franklin and Professor C. R. Mann also spoke of their memories of Helmholtz as a teacher. Professor Mann showed a lantern slide of a photograph which he himself made on July 7, 1894, showing Helmholtz at his lecture desk only a few days before his last illness.

At the regular sessions of the society some twenty papers were presented, special attention being given to physiological optics. A committee was appointed, the duty of which is: (1) To prepare the program of the sessions on vision; (2) to coordinate the work of the society in this field with the work of other societies and (3) to recommend, from time to time, such further steps as may be deemed effective in encouraging research in physiological optics and allied problems.

Rochester is the world's chief center for the manufacture of optical and photographic apparatus. Visits were arranged to go through the research laboratories of the Eastman Kodak Company and the glass plant, optical shops and observatory of the Bausch and Lomb Optical Company. The research work of these laboratories is of great magnitude and even in contributions to pure science may soon rival the chemical and physical laboratories of any university.

## SCIENTIFIC ITEMS

WE record with regret the death of Alexander M. Gray, professor of electrical engineering in Cornell University; of Seymour C. Loomis, formerly secretary of the section of social and economic sciences of the American Association for the Advancement of Science; of Dr. Emil A. Budde, German electrical engineer; of Emile Houzé, professor of anthropology at the University of Brussels and at the Ecole d'Anthropologie of that city; and of Sir William Edward Garforth, pioneer worker for safety in coal mines.

DR. HARLOW SHAPLEY, formerly of the Mount Wilson Solar Observatory, has been appointed director of the Harvard College Observatory in succession to the late Edward C. Pickering.

PROFESSOR GEORGE C. COMSTOCK, who has been director of the Washburn Observatory at the University of Wisconsin since 1889, will retire at the end of this year. His place will be taken by Dr. Joel Stebbins, formerly of the University of Illinois department of astronomy and director of its observatory since 1913.

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